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# ILLINOIS TECHNOGRAPH

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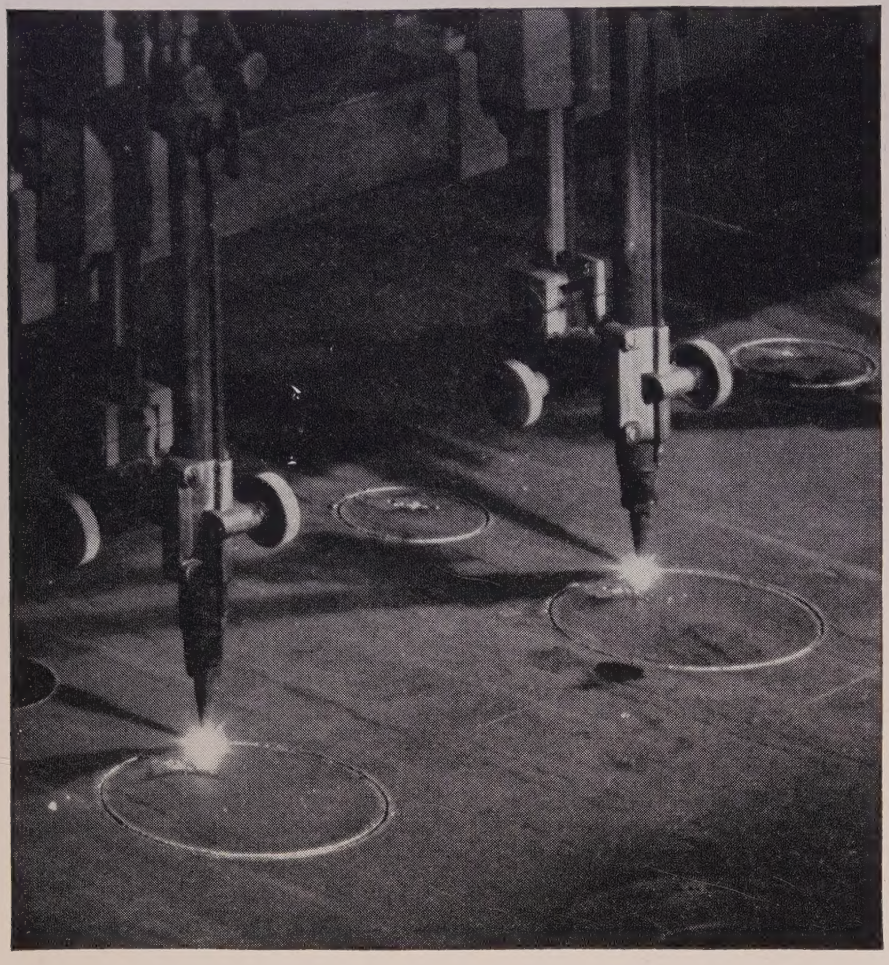
# Only STEEL can do so many jobs so well



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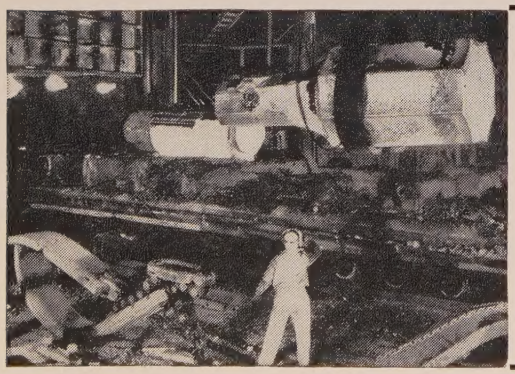

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# *Vice Versa —*

Now that another term has started and old arguments are due to get their perennial renewal, this little story may be tossed around the field for what it's worth. It cost me eighty dollars.

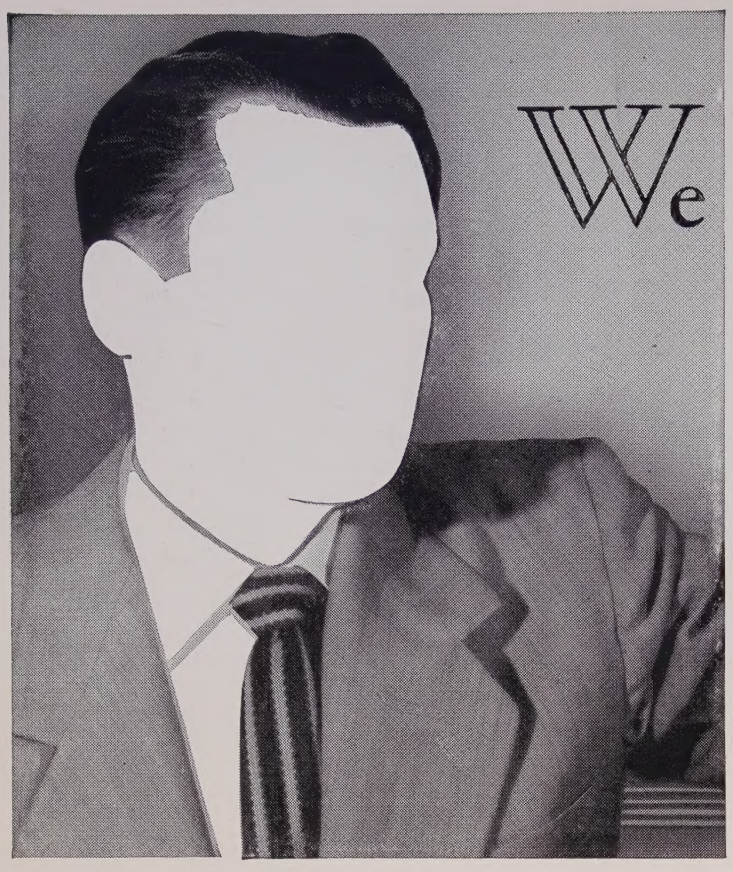
When vacation started this summer, I, like a true-blooded Illini, fastened my little brood around me and struck out for the hinterlands. Behind me, besides dusty books and momentarily interrupted "cherished memories," was a 9 cu. ft. refrigerator. This along with the other furnishings of my apartment, our summer tenants swore to care for "as their own." The old beast (the refrig) was grumpy, her oil seals were stiff, and sometimes this caused her to forget to turn herself off. An annoying habit. Realizing this, we asked our tenant to call a repairman if the old gal put on a marathon. Our tenant, possessor of a Ph.D. (anthropology, I think) and a long forehead, swore compliance. One month later we learned old Bertha had run herself to death leaving a hospital bill of 80 Yankee dollars for a new motor. **Requiescat in Pace.**

Now the moral of this story may be never take summer tenants, but not altogether. The point is that the owner of that nobly prized possession, the Ph.D., would let a machine run night and day until he "smelled something burning." And in all faith he was treating it as his own!

Soon the North side of the campus will be getting its usual barrage — what a bunch of nasty ole technicians we're making here and how we can't even quote Omar or discuss Spinoza. Granted there is a slight basis of truth here, but must we get "the word" from our southern neighbors who are in turn turning out students who have difficulty changing a washer on a leaky faucet? Tales have been going around lately that this is a world of machines. From the commerce student who has to sell them to the Home Ec gal who has to use them, ye olde LAS student is going to see a lot of machinery. Maybe a well-rounded education works both ways.

Anyone for Engineering 100?

P.E.L.



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To a young man looking for opportunities, perhaps the most important fact about a company is its rate of growth, present and prospective. In a company which has become static, advancement is largely dependent on vacancies occurring through death or retirement. In a *growing* company, new openings for able men are being created constantly, and advancement is restricted only by ability.

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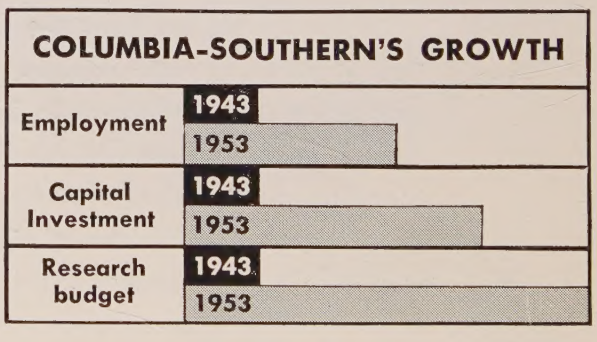
For further information, write now, Dept. P at our Pittsburgh address or any of the plants.

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# THE ILLINOIS TECHNOGRAPH

volume 70 number 1

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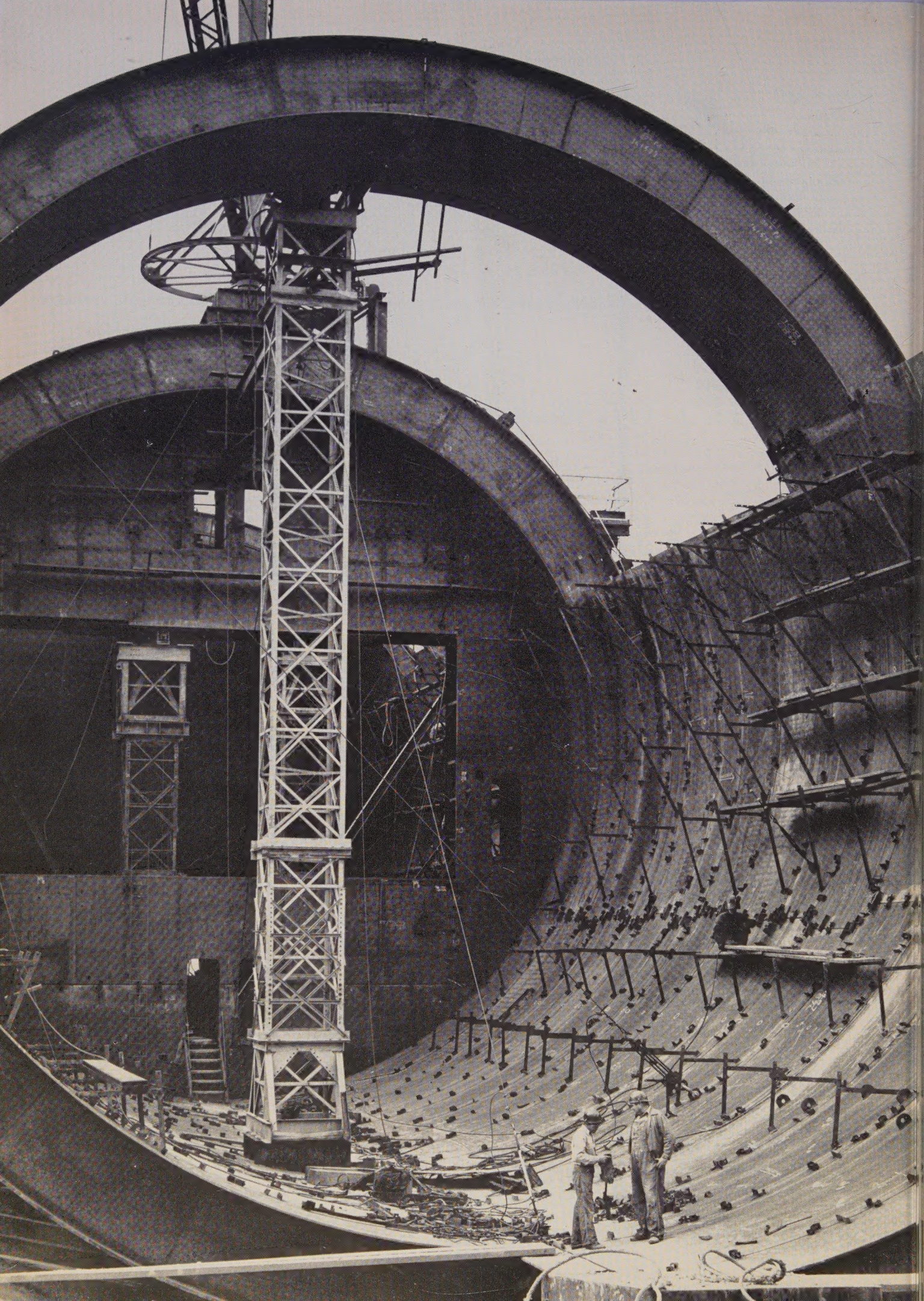
## *our cover*

The Illini Union again welcomes freshmen and upperclassmen as well on their return to campus. Its beautiful Williamsburg architecture is the pride of the campus and it serves as the home of many student activities.

## *our frontispiece*

Transonic circuit ducting of the world's largest tunnel. A test section 16 by 40 feet will be erected approximately where the "lattice-work" extends to the top and bottom. This tunnel will hold engines and their air frames at airspeeds at Mach 0.8 to Mach 1.2.



# *The Story of . . .*

# A. E. D. C.

by Paul E. LaViolette, E. E. '56

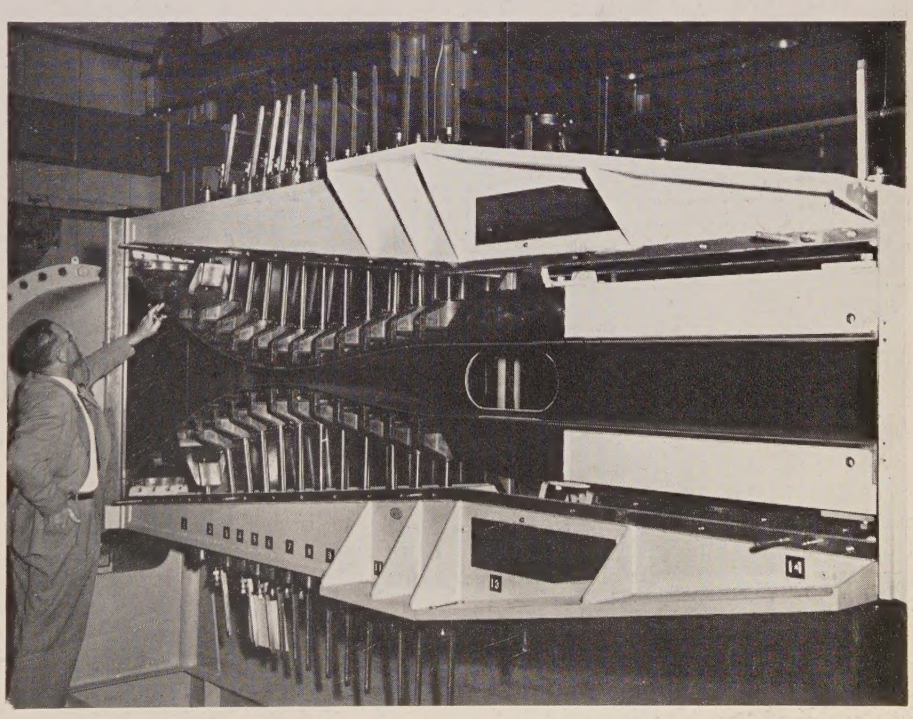
Sixty miles southeast of Nashville, in the "Barrens" of middle Tennessee, there is being built the greatest testing facilities for aviation in the world. The Arnold Engineering Development Center, when finished, will be able to give air frames and engines of future aircraft rigid examinations while simulating flight conditions of almost any altitude, climate, and speed.

The story of AEDC goes back to the end of the Second World War. It had become apparent at that time that German jet research was far in advance of that of the Allies. Earlier in the war the United States, in order to produce planes of quantity as well as quality, had made the critical decision to develop existing type-proven planes. This decision undoubtedly helped win the war, but with the consequence that fundamental aerodynamic research was critically stunted. In November, 1944, General H. H. "Hap" Arnold, then Commander of the Army Air Force, authorized Dr. Theodore von Karman "to investigate all the possibilities and desirabilities for postwar and future war's development as respects the Army Air Forces."

The results of Dr. von Karman's report indicated the need for a super air center, the ultimate cost of which would have been in the neighborhood of $536 million. Disagreement against spending this amount was strong. Although the report was submitted in February, 1947, it was not approved until May, 1948, and then with an appropriation of only $170 million. Construction for the appropriated center was to consist of an engine test facility, a gas dynamics facility, a propulsion wind tunnel and necessary suporting facilities. These, including a ram jet addition to the engine test facility, now comprise AEDC.

Although divided up into three sections, the prime idea of the center is to put plane and engine in windstreams and pressures with varying temperatures and velocities that will duplicate actual air flight. Most of this work is to be carried on in Mach numbers of 1 or greater.

*Mach 1* — For an explanation of Mach numbers, perhaps it is best to start with the well known statement that Mach 1 is the speed of sound. This speed varies proportionately with the square root of the absolute temperature. (As the temperature of the air usually drops as altitude is increased, it is a common fallacy to confuse altitude, as is, as the cause of sound speed change.) At 60 degrees F, the normal temperature at sea level, Mach 1 is about 760 mph. The difficulty experienced at Mach 1 or faster speeds is due to the lack of air molecule preparation prior to the moving surface. Below Mach 1 a pressure wave advances before the surface causing the air molecules to move over, leaving room for the surface to enter the vacated area. At Mach 1 or better the air does not get this initial "brush off" and collides with the moving surface setting up a condition of shock. This shock is the basis of most sonic and supersonic troubles. Mass changes occur with resultant changes at the center of gravity. Drag increases and lift power decreases. And there are more seemingly endless complexities, e.g. flutter of control surface, weight change due to fuel consumption, and of course, landing. The aircraft has to reduce speed below Mach 1 in order to land, but now its wings, which were ideally suited for supersonic flight, provide insufficient lift for subsonic.



Tunnel of gas dynamics facility has a 12 by 12-inch test section. Does testing in the supersonic range on small-scale models of missiles and airframes.

The so called 'sound barrier" does not occur precisely at Mach 1 but varies from Mach 0.7 to 1.3. This speed range is commonly called the transonic region. Speeds from Mach 1 to 5 are called supersonic and those above Mach 5, hypersonic. Those below, naturally, are subsonic.

*Reynolds Numbers* — While Mach numbers cause difficulties to both actual flight in air and simulated flight in wind tunnels, another number, the Reynolds Number, gives trouble only in the wind tunnels. In the wind tunnel, instead of the obvious impracticality of using a full size B36, scale models are used. Models, however, if put in the same conditions as the actual plane, do not respond in the same manner, hence the Reynolds Number. The Reynolds Number is dimensionless and evaluates the ratio of the pressure force to the viscous forces for any flight condition. The ratio consists of:

$$\text{air density} \times \text{relative speed} \times \text{length of the object} \div \text{viscosity of the air}$$

By applying this formula the difficulty encountered by the model may be overcome. Viscosity is dependent on heat (already determined by the Mach number desired) and can't be changed. Increased speed neecssitates larger horsepower motors. Changing the length of the model would defeat the initial purpose. Therefore, as air density is the only factor remaining, many air tunnels are pressurized. All the tunnels at AEDC are pressure tunnels.

*Engine Test Facility*—As mentioned previously, there are three test facilities at the center. Of these three ETF is the nearest to completion, being 95% constructed. Much of the equipment and design at ETF is German. An engine test facility was constructed in Germany during the war at Munich called the Bayerishe Motoren Werke (Bavarian Motor Works). It was completed in 1943 and run for a short period before the surrender. Thereafter it worked for a six month period testing British and American engines, before it was dismantled and sent to the States. The total value of the equipment was $10 million, but this does not include the invaluable knowledge and experience gained by the German attempt. Many of the German engineers came to America with the equipment, not only to work with ETF but in other facilities at AEDC as well. They have become indispensible to the success of the Center.

The original German plant was redesigned for higher altitudes and higher air capacity, and the original single test cell was increased to three and one test bed.

The plant is divided into three sections, the air side, test area, and exhaust side. Air side contains four four-stage 5,000 hp centrifugal compressors which go through a heat exchanger to a coole rdrier. The air is cooled down to minus 11° F in a series of steps, first using lake water, then chilled water, and trichlorethylene. From here it may be rerouted through heat exchangers to obtain exact heat.

The test area contains the three test cells and their control rooms. Each control room controls the engine inside its cell, whereas a master control room on the extreme end of the building controls the cells themselves. T.V. cameras monitor the engine in the cell to help prevent fire hazards and detect the start of any structural failures.

The cells themselves are installed in units so that the whole or part of the cell may be removed on small carts to help speed the installation of engines. The carts are mounted on rails and can be speedily transported to various sections of the facility.

All test data will be processed by an ERA digital computer, that will enable a test crew to get final data within 30 seconds after the material is received. This is accomplished by direct connection of the test cells' data to the remote computer.

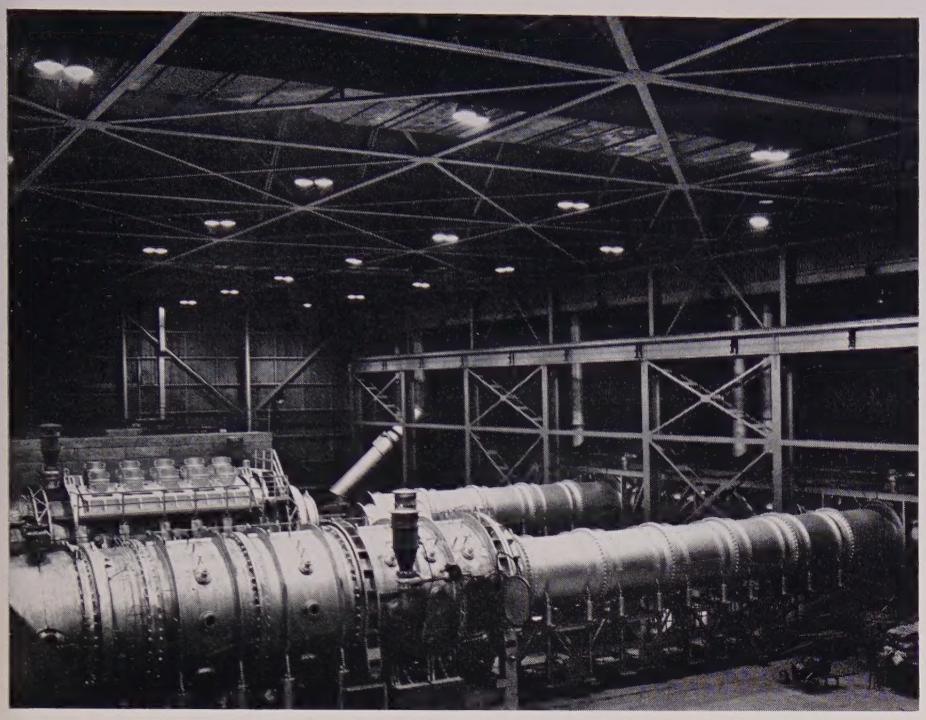
*Ram Jet Addition*—The RJA, while mechanically an dadministratively linked to ETF, is developing into the size of an independent facility. The Addition, still in the early stages of construction, consists of a test cell, two additional compressors, and two giant heaters. Air is to be obtained from ETF partially compressed. The RJA requires an additional 75,000 hp for its compressor and heaters besides the 20,000 hp that has been spent to compress the air at ETF. The return air is to be run through two 30,599 hp exhausters and then back through ETF's 40,000 hp exhausters.

Two additional cells slightly larger than the present cells are planned. With new appropriations, it is hoped construction on these will be started as well.

*Gas Dynamics Facility*—At ETF our problems with the engine were well taken care of, but what of the airframe itself? As stated earlier, we want as high a Reynolds Number as can possibly be obtained, but imagine the size of the motors necessary to cause air flow of super and hypersonic proportions. To overcome the difficulty of a high Reynolds Number in a high Mach tunnel, an intermittant or "Blow-down" tunnel is used. This consists of a chamber filled with pressurized air of approximately 250 atmospheres connected to a test cell which in turn is connected to another chamber that has had its air evacuated. If two connected quick-opening valves are placed at the test cell end of the chambers we will have our desired high Reynolds and Mach numbers.

This idea, by the way, we also owe to the Germans. Design for tunnels of this type were found in Germany at the end of the war. California Institute of Technology undertook to do much research in this type tunnel, and the one cell at present in operation at GDF is a direct copy of a Cal Tech tunnel, but modified for higher Reynolds Numbers.

ETF main control room. Here the configuration of altitude, temperature and wind speed are determined for the various cells.



ETF test cells. In the foreground can be seen T-4. Ducting to the right is the upstream end leading into the compressor end of the building.

The uniqueness of the GDF tunnel lies in its two chambers. On the pressure side instead of having several bottles in tandem, one long 4 foot diameter bottle is used. "Long" in this instance is 720 feet, or about the length of two and a half football fields. The reason for the use of a single bottle is its possible later use as a shock tube. Needless to say, it will be the longest shock tube in the world, but at AEDC such adjectives are everyday occurrences. On the vacuum side the chamber is in the shape of a 72 foot diameter sphere which can be evacuated .1 atmospheres. The two together might represent GDF on a heraldic motif of AEDC in the form of a golf club and ball.

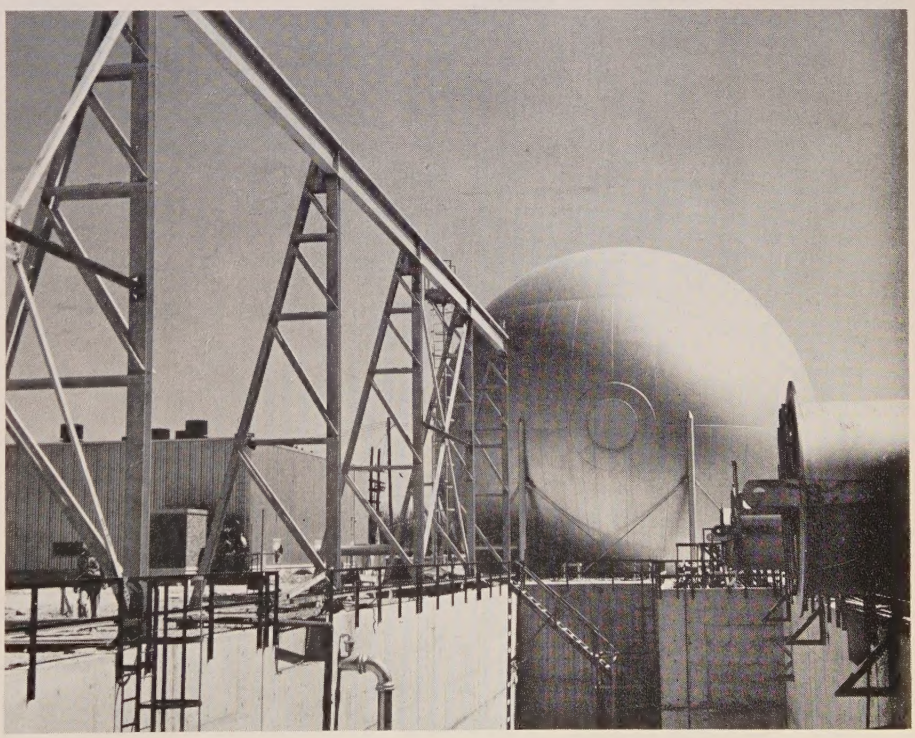
At present, as stated, there is only one tunnel in operation in GDF, E-1. E-1 is a 12 inch by 12 inch supersonic tunnel. There is planned another tunnel of similar size to E-1, which is to be a hypersonic tunnel. These two tunnels will be just starters as two larger 40 inch by 40 inch supersonic and hypersonic tunnels are planned. These giants at present just have their beds constructed and the first test work will not take place until early next year. These will differ from the smaller in that they will be of continuous flow instead of intermittant. The time of tests run with the bottle and sphere last but a few seconds to perhaps 15 minutes, whereas A & B will carry on continuous runs. This will be accomplished by large batteries of compressors and exhausters housed in a building that would do credit to a medium sized factory. Compressors in series stretch for an eighth of a mile, added to the "fans" or the test cell area reduced, the air speed will not go above Mach 1. All energy used in trying to overcome the speed of sound is used up in shock losses. In the supersonic region the situation is the reverse of the transonic region. Here the larger the test cell in ratio to the rest of the tunnel the greater the air speed above Mach 1. At GDF variable throat nozzles are put in the upstream section of the test cell; by varying the angle of opening into the cell, the Mach number can be controlled. Variable throat nozzle research is a big item at AEDC, not only for GDF with its hyper—and supersonic tunnels but at PWT with its transonic tunnel. Only through fine control at the throat openings can the Mach number be controlled.

*Propulsion Wind Tunnel*—The biggest thing at AEDC—which is a way of saying a giant among giants—is the Propulsion Wind Tunnel. This facility will consist of two large tunnels, one and are capable of pressure from 1 pound absolute to 2,500 pounds absolute.

Since time has been taken to go through the mysteries of Mach and Reynolds numbers, a few more words on another peculiarity of air traveling at sonic speeds in a wind tunnel might be of interest. In subsonic tunnels the test cell area is smaller than the rest of the tunnel. Air running from a larger to a smaller orifice, in this case the test area, increases in speed. Thus by either increasing the amount of air going through the larger portion of the tunnel or decreasing the cross section of the smaller, the speed of the air through the test cell may be increased. This is the situation up to Mach 1. Here the situation changes. No matter how much horsepower is transonic and the other supersonic. Together they form quite a collection of superlatives. For example:

Largest cross-sectional area of any tunnel in existence.

Electric motors will turn the world's



The GDF sphere may be exhausted to 0.1 atmospheres. In the foreground is the GDF trench.

largest rotating machinery. These will be assembled on the site. The roof is being removed to allow passage of some of the bigger parts.

Cooling water will be used at a rate comparable to that of a city the size of Washington, D. C., every day.

In order to minimize the problems encountered in the big transonic tunnel, a smaller tunnel, one sixteenth the size of the larger, has been built, and dubbed Pee Wee. The variable throat nozzles for the transonic tunnel designed to go through the tricky zone of Mach 0.9 to 1.6 have been proven in the smaller tunnel. Westinghouse contracted to build the rotary machinery for the tunnels, and has taken advantage of the smaller tunnel to insure success on the large machinery.

The name Propulsion Wind Tunnel was derived from the unusual fact that airframes tested will include their respective engines, attached and in full operation! So here are the efforts of both GDF and ETF combined so as to see the proven component parts work successfully as a unit.

ETF is not out of the picture yet, however. Since the air and exhaust demands of PWT are so great, the entire air and exhaust section of ETF are used. Therefore, to prevent interference with ETF, PWT will be run only at night. This turns out to be ideal as the power requirements (power is from TVA) are so large as to be scheduled for off-peak hours. To make another comparison, we might say that the annual power usage will about duplicate the yearly use of a city the size of Memphis, of 5 to 7 million kwh.

At the present only the transonic tunnel is under construction. Money for the supersonic tunnel has just been approved in the last Congressional appropriation. The supersonic tunnel is scheduled to have its "Pee Wee" too. The two tunnels will use the same set of drive motors. These motors will have a capacity of 216,000 horsepower.

The installation of the test units operates similiarly to an old time slide projector in the model assembly shop. The units are assembled in giant individual stalls on 300 ton, 40 foot test section carts. When ready the cart is mounted on a railway car (extra large) and rolled up to the tunnel. Here another unit having run through its paces is rolled out and the new "slide" is slipped in.

*Auxiliaries*—In order to supply the facility's gigantic thirst for water, a dam has been built across the Elk River and a 75-mile-shoreline reservoir made. The reservoir in combination with a small reservoir on the site can deliver 150,000 gpm. Besides cooling water for the site, the reservoir is a boon to the community, offering swimming, motorboating, and fishing along its miles of shoreline.

An airfield is planned with an 8,000 foot air strip and hangars. When constructed this will facilitate handling of test items and industrial personnel direct with the Center.

## New Polymer

Rubbery parts with properties intermediate between those of silicone rubber and organic rubbers can now be pro duced by compounding with a new silicone polymer that can be vulcanized with sulfur and blended in any proportion with organic rubbers.

Identified as Dow Corning 410 Gum and available now in commercial quantities, this new polymer can be blended with or applied as a protective coating to extend the serviceable temperature limits and the weather resistance of organic rubbers. Brittle points in the range of —70°F and usefulness at temperatures up to 400°F can be realized by proper blending. The physical properties of the blend will fill between those of high strength silicone rubber and the organic rubber constituent.

Dow Corning 410 Gum can also be blended with oil resistant rubbers to increase their stability in contact with hot oil. Such blending also markedly improves the ozone and weather resistance of organic rubber.

Treated in an atmosphere created by an ozone generator, for example, a Buna N type rubber, compounded for test purposes, showed failure cracks in less than 30 minutes. Under the same conditions, a fifty-fifty blend of the same organic elastomer and Dow Corning 410 Gum, compounded with the same fillers and vulcanizer showed no cracks after more than 8 hours.

## NEW BIBLIOGRAPHY

Listing a bibliography of 136 different reports on the subjects of bearings, lubricants and lubrication, The American Society of Mechanical Engineers, in its official publication Mechanical Engineering, published a digest of studies made during 1953.

The comprehensive summary was prepared by Dr. J. C. Geniesse and H. A. Hartung, with the assistance of the ASME Research Committee on Lubrication. Based on the Engineering Index references on bearings and lubrication, the digest correlates the various studies under specific subject groups to simplify reference to the bibliography.

Titled, "A Digest of 1953 Literature —Bearings, Lubricants and Lubrication," the summary appeared in the September issue of Mechanical Engineering.

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# WHY STUDY MATH?

(Reprinted from General Electric Review)

Do you know what's going to become of you when you get out of high school?

If you don't, you'd better start thinking about it. Of course, maybe you *have* thought about it. Maybe you're planning to go to college. But if that's the case, it only changes the question a little: Do you know what's going to become of you when you get out of college?

By this time you're probably thinking: "So what?" The answer to that is this: No matter what you plan to do when you get out of high school or college, you're probably going to need more mathematics.

Yes, let's face it. Unless you're an exception, you need more math. No matter whether you plan to go on to college or not, no matter what you plan to do after college, chances are you won't have enough math. Many of the fellows and girls who went through school ahead of you found out they didn't have enough math. So they had to make it up to take the courses they wanted or to get the jobs they wanted.

It's a lot harder to catch up on mathematics later on. The time to think about it is now, while you're still in junior or senior high school. If you start early enough, math shouldn't be much trouble at all. Trouble is, the fellows and girls in high school don't realize how important it is to get a good groundwork in math. So we're going to try to explain it to you. First we're going to try to show you how important math is and why you're going to need it, no matter what you do after you finish school, and then we're going to try to show you that math isn't such a tough subject after all.

### *Why Math Is Important*

Mathematics is going to be important to you no matter who you are or what you expect to become after school. Some people don't need much; they can get along with nothing more than arithmetic. Others need more math—maybe algebra, or geometry, or both. Still others need a lot of math—things like trigonometry or calculus. Let's take a few cases. Let's start at the top and work back; let's start with the people who need a lot of math.

The world today is pretty complicated. It's changed a lot in the past 40 years. Forty years ago there weren't very many scientists and engineers; the world was only just beginning to realize how important science and engineering are. The automobile was just getting started. Airplanes were a novelty. Radio and television hadn't been born yet. Most homes had no electricity; they got their light from oil or gas, they cooked on a wood, coal, or gas stove, they kept their food in an icebox, and they washed their clothes in a wash tub with a hand scrubbing board.

So they didn't need very many technical people in those days. Over a third of all the people who worked were unskilled; they needed very little education—they worked mostly with their muscles, not their brains. Today, although there are still more unskilled workers than any other occupation, *their total number has dropped from 13,400,000 to 11,500,000, while the total number of people working has increased from 37,300,000 to 55,800,000!*

Meanwhile the number of skilled and semiskilled workers went up over the same period. The skilled workers jumped from 4,364,000 to 7,632,000, and the semiskilled workers doubled, jumping from 5,500,000 to 11,000,000.

Back in 1910 there were only 60,000 engineers in the whole United States. Only one out of every 621 people working as an engineer. That wasn't very many. But by 1950 the number of engineers had increased to 400,000—one out of every 139 persons working was an engineer.

### *We Need Trained People*

Yes, the world is pretty complicated today, compared to what it was 40 years ago. And it's getting more complicated all the time. This means that we have to have more and more specially trained people. [We need them not only to work out the really tough problems of science like learning how to harness the power locked up in the atom—we need them not only to produce the new and wonderful materials like plastics, to find new ways to conquer disease, to design the machines of industry and the labor-saving gadgets of the home—we need them more and more for the ordinary things of every day life.]

It takes special training nowadays to be a good carpenter, or a plumber, or an automobile mechanic. But those are simple compared to electronics. We used to think a radio serviceman had to have a pretty special kind of training, but it's much tougher for a TV serviceman today.

Right now some of you who read this are probably thinking: "That's all right for technical people, but I want to be an artist, a druggist, or a nurse," or "I want to go into business for myself. What on earth good will math do me?" All right, let's see.

Most artists today go in for what artists call *applied* art. They want to use their ability to draw and paint in advertising, or interior decorating, or something that will pay them good money. But the people in business who hire the artists for that kind of work say that simple artistic ability is not enough any more. There are lots of fellows and girls with artistic ability, but not enough of them know anything about physics, mechanical things, or mathematics.

To be a druggist you have to be a chemist. This means you have to study chemistry. And don't let anyone tell you that you can learn chemistry without knowing something about algebra.

How about a nurse? One of the required subjects in a course of nursing in a modern hospital is known as Materia Medica, and one of the things you'll learn in Materia Medica is how to figure out doses and solutions of medicines and the like. Algebra is important in doing the figuring. Too many nurses flunk out of the course nowadays because their math is weak.

It's the same thing with a trade. Whether you want to be a draftsman, a machinist, a molder, or a pattern-maker, you'll find out that you need algebra and geometry, plus other things like trigonometry.

Even if you want to go in business for yourself, you'll still need math. For business today, whether it's running the little gas station at the corner or the big factory down by the river, it takes good management and good management takes mathematics.

The most important of all needs for mathematics are the needs of those who are going to keep up the wonderful progress we're making these days in science and engineering. There's a great demand for such technically trained people. They're needed in the offices and factories that turn out the things we need in peacetime and develop new ones

for tomorrow. And our military forces need them, too—badly.

### *War Is Complicated*

For war is a very complicated business, also. It isn't like the old days, when big armies met in battle and slugged it out hand-to-hand. Nowadays a war is fought with airplanes and battleships and tanks and radar and atom bombs. We fight our wars as much with machines as we do with men, and we need men with special training to run the machines. We need them to pilot the planes, to operate the radar, to control the gun turrets on bombers and battleships with such accuracy that even the rotation of the earth is sometimes taken into account.

The people who run our business and military affairs know how badly we need people with special technical training, and they're doing everything they can to persuade more people to get that training. For there just aren't enough trained people to go around. The jobs are there, waiting for them when they get out of high school or college, but not enough fellows and girls are studying the right things.

Trouble is, they don't start early enough. This means that, if you want to be an engineer or a scientist or almost anything at all these days out of the ordinary, you've got to start thinking of it now, while there's still a chance to study those subjects you need to start with. And the most important of these rock-bottom subjects is mathematics.

But the fellows and girls in high school aren't getting enough math. The United States Office of Education says that only 20 per cent of all high-school students are taking math. Why so few?

There are probably a number of reasons. Maybe you, like many others, don't think you're going to need math in the work you're going to do. And it's true that there are plenty of jobs open where you don't need anything but just plain arithmetic. An athlete, for example, or a farmhand, or a sales clerk, or the operator of a telephone switchboard. There's still a big need for people who are skilled with their hands or who have strong muscles.

### *What About Computers?*

Maybe you've read about those wonderful computers or calculating machines that are being built today—machines that work by electronics to do all sorts of complicated problems in mathematics at terrific speeds. Maybe you think we should let those machines do our math problems. If you do, you haven't got the right story about the computers.

The point is that a computer is no better than the human mind that designed it or the human mind that runs it. It has to have a mathematician to run it. The only difference between the man and the computer is that the machine works faster. Somebody has to analyze the problem, "set it up," and feed it into the machine before the machine can solve it. (We'll tell you more about this business of analyzing later on.) Computers are a big help—but don't think we can leave it to machines to do all our math for us.

There's still another angle you shouldn't forget. True, you can get along these days without much more than simple arithmetic if you're not particularly ambitious, but there are lots of times that more math would be a big help to you in your everyday affairs.

A famous British mathematician says that we live surrounded by figures—cooking recipes, railway timetables, unemployment insurance, fines, taxes, war debts, schedules of working hours, speed limits, bowling averages, betting odds, calories, automobile and truck weights, temperatures, rainfall, hours of sunshine, miles per gallon, electricity and gas meter readings, bank interest, parcel post and freight rates, radio wavelengths, automobile and bicycle tire pressures, and many more. And we need to know how to use our figures. Let's take a very simple example.

Suppose you have to drive somebody to the station to catch a train. The station is two miles away, and you have four minutes to get there before the train leaves. You start out in the car, and you drive the first mile at 15 miles an hour. Then all of a sudden you realize you'd better speed it up if you want to make it. How fast do you have to drive that second mile in order to get there before the train leaves?

Don't spend too much time figuring it out, for there's a catch in it. No matter how fast you go, you can't make it. You used up your whole four minutes driving that first mile. But the point is that it takes algebra to solve a simple problem like this. Anybody who's had elementary algebra should know right away that he should drive faster than 15 miles an hour to make the train.

There are lots more cases in everyday life where simple arithmetic is not enough, and more math would be a great help. A little application of the principles of geometry, for example, would help you in parking the family car. If you play baseball and want to hit a home run, you might wonder which is more important, a heavier bat or hitting the ball harder. There's a mathematical formula in physics which tells you that it's more important to hit the ball harder.

When you get married and set up housekeeping, there will be lots of times when you could use a little more math to help you solve every day problems. You may want to figure out whether it's worth while to turn down the thermostat at night when you go to bed, so the furnace won't use so much fuel. But you'd probably have to use some advanced math like calculus in order to find out whether you'd really save fuel or not.

### *Who Sits Where?*

Take a simple little thing like figuring out who sits where at a dinner party. You're going to have six people at the table. Believe it or not, there are 720 different seating arrangements for six people! Figuring out things like that is easy—if you have enough math.

Take the case of the fellow in Milwaukee not so long ago who was picked up by a motorcycle cop for speeding. The cop didn't check the speed on his speedometer; he was stationed at a street corner and he guessed the speed. They went before the judge in police court and the driver of the car got the cop to admit that the car had stopped for a traffic light just before the arrest was made. The driver then proved to the judge *by mathematics* that no car in existence could have picked up speed fast enough to be exceeding the speed limit where the cop was stationed. And the judge let him off.

But there's still one more reason why you should study more math now, while you still can get the ground-work. Even if you aren't going to need more than arithmetic in your job when you get out of school, even if you decide you can get along with just arithmetic in solving your everyday problems, you still may be the kind of person who needs to know something about advanced math to get the most out of life.

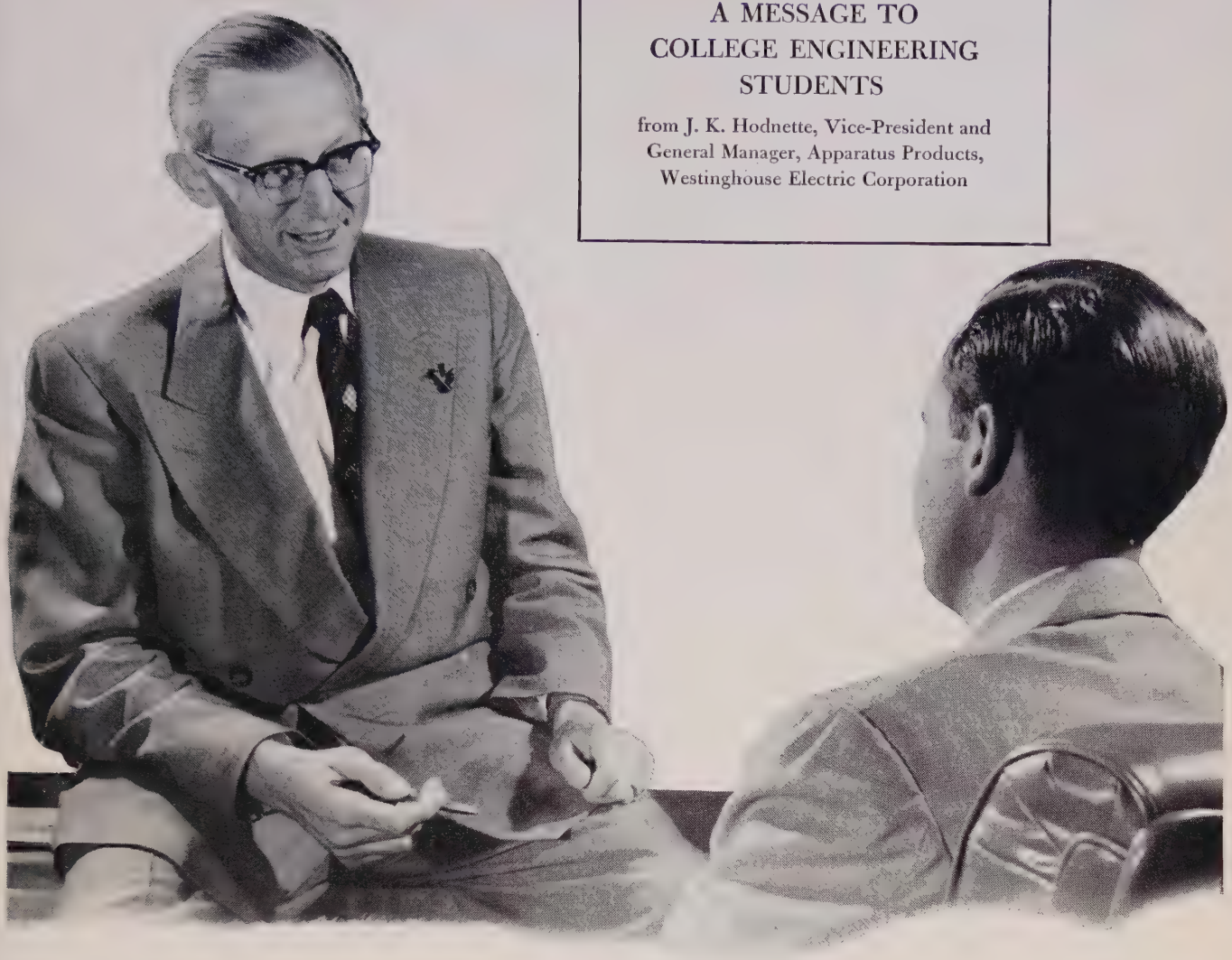
Now some people are satisfied to go on living from day to day, having a good time but not caring much about anything else. But there are lots of people who aren't content to live that kind of life. They're interested in life, and other people, and what makes the wheels go around—what makes it rain or snow, what the stars are, or what makes radio and TV work. Such people are just plain curious about things. They like to learn as much as they can, because they're interested in everything that goes on.

Trouble is, if you're that kind of person, you almost have to learn something about the more advanced branches of math if you want to understand the things you get curious about. Algebra and geometry are so important to an all-round education that it's hard to get through high school without taking those subjects. And many colleges make you study more than that just for a general all-round education.

If you want to learn something about astronomy and how it's possible to measure the distances to the sun or the

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from J. K. Hodnette, Vice-President and
General Manager, Apparatus Products,
Westinghouse Electric Corporation



# To the young man with a vision of success

Success means different things to different men. It can mean professional recognition, or great achievement, or exciting work, or many other things. Whatever its special meaning to you—keep its image in your mind, for you are already well on the way to achieving it!

If you are *determined* to become a research scientist, you *can* be. If you have a burning ambition to become a sales engineer, you can be. If you have your sights set on a top executive spot, you'll be there someday. One might think a large company like Westinghouse would have more pressing things to think of than the ambitions of its young engineers. On the contrary, nothing is more important . . . for our professional people are our biggest asset.

Here at Westinghouse, intensive efforts are made to help our professional men realize their individual goals —through extensive training programs, study programs leading to advanced degrees, leadership programs, and guidance in professional development. You are treated as an individual at Westinghouse.

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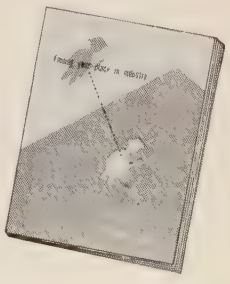

moon or the stars, you've got to know something about trigonometry. If you want to understand the laws which govern the working of the universe which includes our earth, the sun, and all the stars, you have to understand the calculus.

Suppose you're interested in economics. That's the study of such things as inflation and banking, whether we're going to have enough food or gadgets or machines to go round, and what we're going to use for money. The fellows who study economics are great ones to use statistics, and in order to make their statistics easy to understand, they make graphs or curves of them. This comes under the subject of analytical geometry —a handy subject to know if you're interested in economics.

### *A Brick Problem*

Before we finish thinking about the importance of knowing more mathematics than just simple arithmetic, let's take one more example of the use of math to solve a simple problem. The problem is the sort of thing that might come up in one way or another to bother anybody nowadays. Although it might be about anything from shoes to automobiles, let's use bricks for example. This is our brick problem:

*A brick weighs 10 pounds plus a half a brick. How much do two bricks weigh?*

Now actually there are three ways to solve that problem. The hardest way is the way a fellow would do it if he didn't know any more math thon simple arithmetic. We could call this the guessing method. By this method, you'd say that one brick must weight more than 10 pounds—perhaps 12 pounds. But we were told that a brick weighs 10 pounds plus a half a brick, and if one brick weighs twelve pounds, a half a brick weighs 6 pounds, and 10 pounds plus 6 pounds is 16 pounds, not 12.

So we try again. If we try 15 pounds next, we find it still doesn't work, for then 10 pounds plus a half a brick (7½ pounds) would be 17½ pounds. Not until we try 20 pounds do we find that it works, for then 10 pounds plus a half a brick equals 20 pounds. This makes two bricks weigh 40 pounds, which is the right answer.

An easier way to solve the problem is to do it with algebra. If we let x equal the weight of one brick, then we can set up a simple equation and solve it out like this:

$$\begin{aligned} x &= 10 + \tfrac{1}{2}x \\ x - \tfrac{1}{2}x &= 10 \\ \tfrac{1}{2}x &= 10 \\ x &= 20 \\ 2x &= 40 \end{aligned}$$

In other words, two bricks weight 40 pounds, which is the same answer we got by the guessing method.

There's still a third way to do it. It's the easiest one of all. To anyone well grounded in math, particularly algebra, this problem is so simple that he sees the essentials right away; he can figure it out in his head. He may be unconsciously doing it by algebra, but if you were to ask him how he did it, chances are he wouldn't say he used algebra at all but just common sense or logic.

And that's the beautiful part of a good groundwork in math. It helps you to think things out logically. For mathematics is just an application of the principles of logic.

### *What Is Math, Anyway?*

And this brings up a question that ought to be answered right now: What is mathematics, anyway? A lot of people have a completely wrong idea of math as something that's terribly hard to learn, something mysterious, something that only "brains" and geniuses can get good marks in. Well, if that's the way you feel about math, you're wrong.

When you came right down to it, all—or nearly all—of mathematics, no matter how advanced, no matter how strange it may seem, is just the four simple parts of arithmetic: addition, subtraction, multiplication, and division. The more advanced branches of mathematics teach you how to use these four parts of arithmetic to solve harder problems, and they teach you how to do those four things *fast*.

For we use the simple kinds of math as stepping stones to reach the more complicated kinds. Once we learn addition, subtraction, multiplication, and division, it's easy to learn algebra. Once we learn algebra, it's easy to learn geometry. Logarithms are just a kind of short cut to help solve problems in arithmetic. Algebra's another short cut.

Geometry, however, isn't really mathematics at all. It's the logical study of the shapes and sizes of things. We just use math in figuring out the measurements and capacities of geometrical figures—how big they are or how much you can put into them.

Trigonometry is the next stepping stone after geometry. It uses some of the things we learned in geometry as too's for measuring distances. With trigonometry we can do surveying—or we can measure the distance from the earth to the moon, the sun, or even some of the stars. But when you solve a problem in trig, you still use arithmetic: addition, subtraction, multiplication and division.

The calculus is a very wonderful branch of math. While geometry and trigonometry are used to figure out problems about things that are standing still, so to speak, the calculus is used to solve problems about things that are always changing, like the speed of a bomb dropping out of an airplane. Yet the calculus is just a more elaborate method of using addition, subtraction, multiplication, and division.

One kind of math that often scares those who don's know much or anything about it is the use of formulas and symbols. They look strange to us, and because we don't know what they mean, they may scare us a little. But there's really nothing to be scared of, for such things are just a kind of shorthand which mathematicians, scientists, and engineers use. They use them as a simple way of writing complicated ideas or methods of solving problems.

### *Serve the Pi*

Probably the best known of these is the Greek letter pi. If you've studied geometry, you know it's the number of times that the diameter of a circle can be divided into its circumference—about 3 1/7 times, roughly speaking. The actual figure is a very complicated number, for when you divide the circumference of a circle by its diameter it never comes out exactly; the answer keeps running on and on to more and more decimal places.* So, because it's impossible to write it down exactly, we use a symbol for it. Although this symbol, pi, has many other uses in mathematics, most people know, when they see it, that it means the number of times the diameter of a circle can be divided into its circumference.

It's the same way with other symbols. Every one of them is just a kind of shorthand for something longer and more complicated. When you get a mark of A— or maybe F—on an examination paper or your report card, it tells you how well yo udid. If it weren't for the symbol, somebody might have to write a lot of words like: "This is a very good paper," or "This student didn't pass."

That's the way it is with all the signs and symbols of math. Every one of them means something long or complicated, and it saves time and space to use the symbol.

Don't think that the mathematicians and engineers and scientists can understand all the symbols. Some of the signs, of course, like pi, are pretty well known. But many of them are used only by people in special kinds of work, and people in other kinds of work may not known any more about what the signs mean than you do.

Formulas are used in the same way. People who study physics have proved by experiments that, if you're trying to knock a home run, its more important to hit harder than it is to use a heavier bat. They've figured out just what difference it makes when you use something heavier to hit with, and how much

*Here's pi to ten places: 3.1415926535. Although mathematicians have figured out its value to over 1,000 decimal places, no more than ten decimal places are ever needed for the most precise work.

# THE ALUMINUM INDUSTRY WAS BORN ON SMALLMAN STREET

▼ In 1888, the aluminum industry consisted of one company—located in an unimpressive little building on the east side of Pittsburgh. It was called The Pittsburgh Reduction Company. The men of this company had real engineering abilities and viewed the work to be done with an imagineering eye. But they were much more than that. They were pioneers . . . leaders . . . men of vision.

A lot has happened since 1888. The country . . . the company . . . and the industry have grown up. Ten new territories have become states, for one thing. The total industry now employs more than 1,000,000 people—and the little outfit on Smallman Street? Well, it's a lot bigger, too—and the name has been changed to Alcoa. ALUMINUM COMPANY OF AMERICA . . . but it's still the leader—still the place for engineering "firsts".

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difference it makes when you hit harder.

When you hit with something twice as heavy, it does twice as much good. But when you hit twice as hard, it does four times as much good. When you hit with something three times as heavy, it does three times as much good. But when you hit three times as hard, it does nine times as much good.

It wouldn't be easy to remember how much difference it makes, depending on whether you hit harder (increase the velocity, that is) or use something heavier, if it weren't for this simple little formula:

$$E = \frac{MV^2}{2}$$

The formula may look strange to you, but don't let it scare you just because of that. It's just a combination of signs arranged in the form of an equation in algebra. Each of the signs has a pretty simple meaning. If you know the meanings, you can read them just as you read a sentence in English.

Translated into English, that formula says:

*Energy (E) equals half the product of the mass (M) times the square of the velocity (V).*

You can translate it still more if you want to. But the point is, that compact little formula is a very quick and convenient way of saying a much more complicated thing. And if it weren't for algebra, we wouldn't be able to say it so quickly or so simply.

So it amounts to this: if you know what the signs mean, and you have studied algebra, you can understand what most of those strange formulas mean. And when you understand that, youl'll realize all of a sudden that most of the strangeness of higher mathematics or subjects like physics, or chemistry, or electrical engineering, is caused by the strange symbols and formulas that are used. If you learn what the symbols and formulas mean, those things won't seem anywhere near so strange. You'll find they don't scare you anywhere near as much.

### *So Far, So Good*

Now that we've gotten this far, let's stop a moment and get our bearings. If you've understood what's been said, you know these things:

1. The world today is complicated.
2. That means we need lots more people with special training.
3. That means we'll all need more math.
4. Mathematics can help us even if we don't need it in our jobs.
5. All math is based on simple arithmetic.
6. Most all math is just special ways of using arithmetic or of doing arithmetic fast.
7. Much of the strangeness of math is caused by the symbols and formulas, and they're just a convenient sign language.

Before we finish thinking about what math is and how we use it, let's think about one more thing that we learn when we learn math: analysis. When we have a problem, or something happens, and we have to figure out what to do, that's called analysis.

Your arithmetic, your algebra, your geometry, trigonometry, calculus, and other branches of math are the tools you use to solve problems. But you can't use the tools unless you analyze your problem first to see what you've got, what you need to do, and how you should do it. Analysis tells you which tools to use, and how to use them, in solving your problem.

Analysis is the most important part of mathematics. Anybody can learn to use the tools, but unless he learns analysis, he'll never be able to solve problems, even the simplest ones.

If we want to know what per cent 48 is of 60, it's analysis that tells us to divide 48 by 60 to get the answer (80%). In solving that problem of the brick that weighed 10 pounds plus a half a brick, it was analysis which made us decide whether to use the guessing method or algebra. And if we were really good at analysis, we solved it while we were analyzing it.

For that's where analysis gets particularly worth while—when we have such a good grounding in math that we learn to be really sharp in analyzing our problems. And when you remember that analysis is just intelligent, logical thinking, why then you'll begin to see one of the most important things about learning a lot of math. That is: the more math you get, the better you'll be able to think.

Professor Bailey of the University of Michigan said something about that in an article he wrote not long ago. He said that education is mainly along three lines: (1) learning facts; (2) learning to get along with other people; and (3) learning to think better. The first two are not very hard—even a dog can do them. A dog, for example, learns such facts as where his home is, who his master is, and when he gets fed. He also learns to get along with people—if he's had any training, that is.

### *Can a Dog Think?*

But when it comes to the job of learning to think better, that's too much to expect of a dog. Many people believe that a dog can't even think in the first place—that thinking is something that's done only by human beings. All human beings think, but some do a lot more of it, or do it better, than others.

Professor Bailey wondered what it was that made some people think better than others. He said the first thing necessary to be a thinker was to be born that way, like Benjamin Franklin or Thomas A. Edison. *They* didn't have to be taught to think.

But that doesn't mean people can't be taught to think—or think better. Professor Bailey gave the names of some great examples of well-educated people —Elihu Thomson, Steinmetz, Langmuir, Coolidge. Their education, far from interfering with their ability to think must have been a great help to their thinking ability.

Then Professor Bailey asks what studies in school help most to develop the habit of thinking. And the first of these, he says, is arithmetic. In the study of arithmetic the student is made to think logically and accurately— probably for the first time! And its pretty well agreed that the more math you get, the more logically you think.

So it's to your advantage to study as much math as you can, while you still have the chance. And the best time to get a good groundwork in math is while you're still in junior and senior high school. You'll find it much easier to get through college if you get a good grounding in math now. It will help you to get a better job afterwards, too. Most important of all, it will help you to think better and to get the most out of life.

### *Will You Choose One of These Occupations for a Career?*

These occupations need lots of math:

Architect, Aeronautical Engineer, Agricultural Engineer, Astronomer, Ceramic Engineer, Chemical Engineer, Chemist, Civil Engineer.

Electrical Engineer, Geologist, Marine Engineer, Mechanical Engineer, Metallurgist, Mining Engineer, Petroleum Engineer, Physicist.

Pulp & Paper Engineer, Research Scientist, Sanitary Engineer, Surveyor, Textile Engineer.

These occupations need quite a lot of math:

Accountant, Airplant Pilot, Artist, Auditor, Carpenter, Dentist, Dietician, Doctor, Draftsman, Electrician, Housewife, Machinist, Mechanic, Merchant.

Molder, Musician, Nurse, Painter, Plumber, Statesman, Stonemason, Teacher, Writer.

These occupations need arithmetic only:

Athlete, Athletic Coach, Baseball Player, Farmer, Fireman, Football Player, Gas Station Attendant.

Photographer, Policeman, Sales Clerk, Soda Clerk, Stenographer, Telephone Operator.

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A girl's figure is her fortune providing it draws interest.

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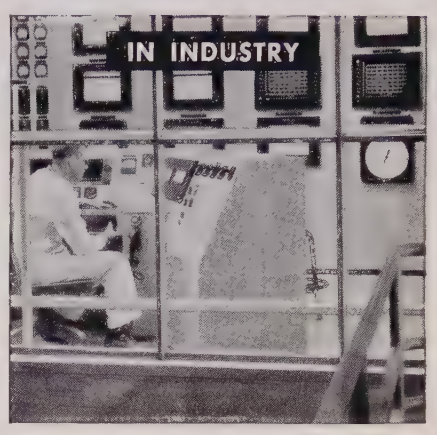

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***Book Review . . .***

# One, Two, Three—Infinity

*George Gamow*
*Viking Press* *$4.75*

(Reviewed by Paul E. LaVielette, E. E. '56)

"'The time has come,' the Walrus said, 'to talk of many things . . . of atoms, stars and nebulae, of entropy and genes; and whether one can bend space and why the rocket shrinks.'" With this as a preface, Gamow starts off perhaps his most far ranging and certainly his most popular book. Gamow has written this book for the layman, and in doing so encounters some difficulty, for he tries to guide his reader through the bogey-land of science much like a scoutmaster leading a group of young cub scouts. Sometimes he remembers his readers are cubs and other times he treats them as eagles. Of course his context is a formidable one and the difficulty of explaining even half of the above subjects in simple language has lain waste scores of educators.

If "One, Two, Three—Infinity" is taken for what it was meant to be, an introductory idea to a wide variety of scientific subjects and ideas, the reader is in for some exciting reading. He journeys the staggering road from microcosmos to macrocosmos, finds infinity in his hand, and loses himself in the space inside an atom. He is introduced to speculations on the beginning and ending of the universe and made to stand like an Atlas in space to view the galaxy spread before him.

If, after the book is laid down, the reader feels a certain amount of imprisonment within the four walls of his room and in his wonder goes to look and to ask for more of the same fare, "One, Two, Three—Infinity" has succeeded in its purpose.

The book is well illustrated by drawings of the author and is written in his usual entertaining style. A pocket book edition by Mentor is printed.

---

I once had a classmate named Jessar
Whose knowledge grew lesser and lesser.
It at last grew so small
He knew nothing at all
And now he's a Thermo professor.

Then there was the case of the young army doctor in the South Pacific, who had diagnosed the ailment of a sergeant, but knowing he could do little with his limited facilities, he wired the base hospital: "Have a case of beriberi. What shall I do?"

The message was taken by a young technician at the base who wired back: "Give it to the engineers. They'll drink anything."

* * *

One of our present troubles seems to be that too many adults, and not enough children, believe in Santa Claus.

* * *

Miriam had not been doing very well in history, although her marks in every other course were high. One day she was called into the professor's office for a conference.

"I do anything if I could pass, Professor, anything at all."

"Anything?"

"Yes, anything."

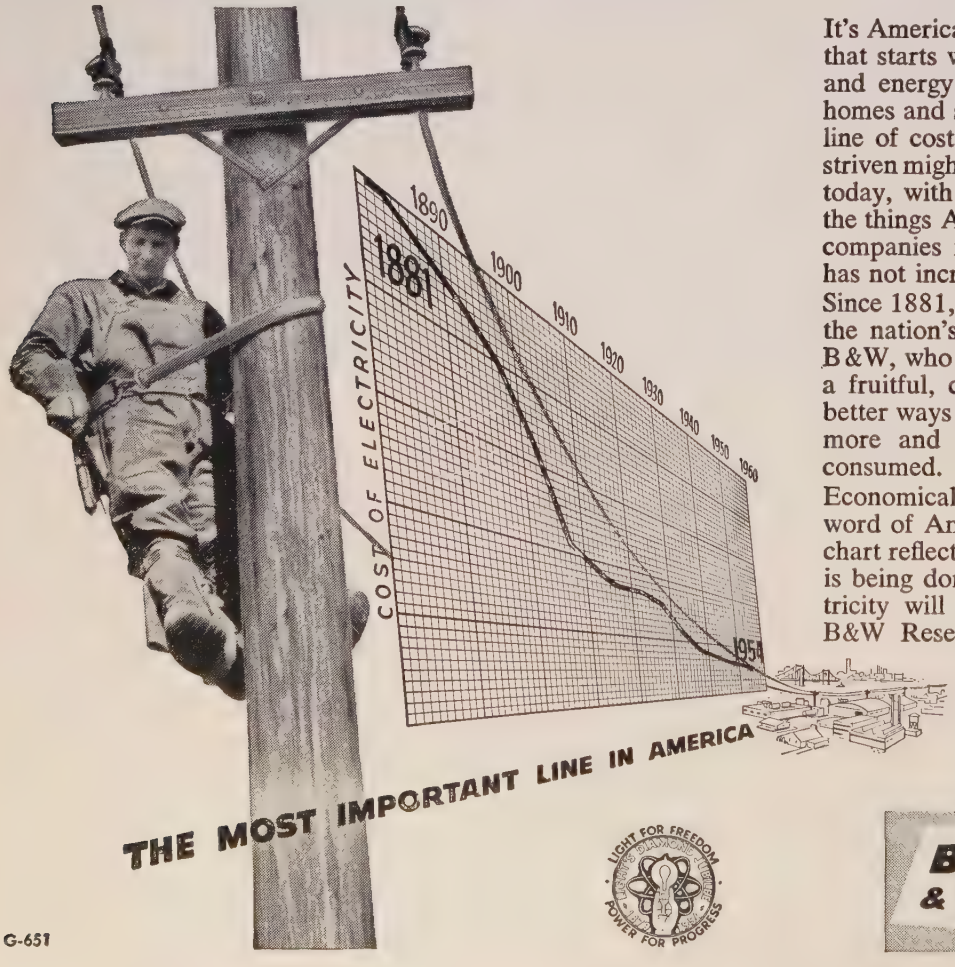
"Are you sure?"

"I just have to pass, Professor, yes, I'd do anything."

"Hmmmm, what are you doing Friday night, Miriam?"

"Why, nothing at all, Professor."

"Well, Miriam, I think you might do a little studying."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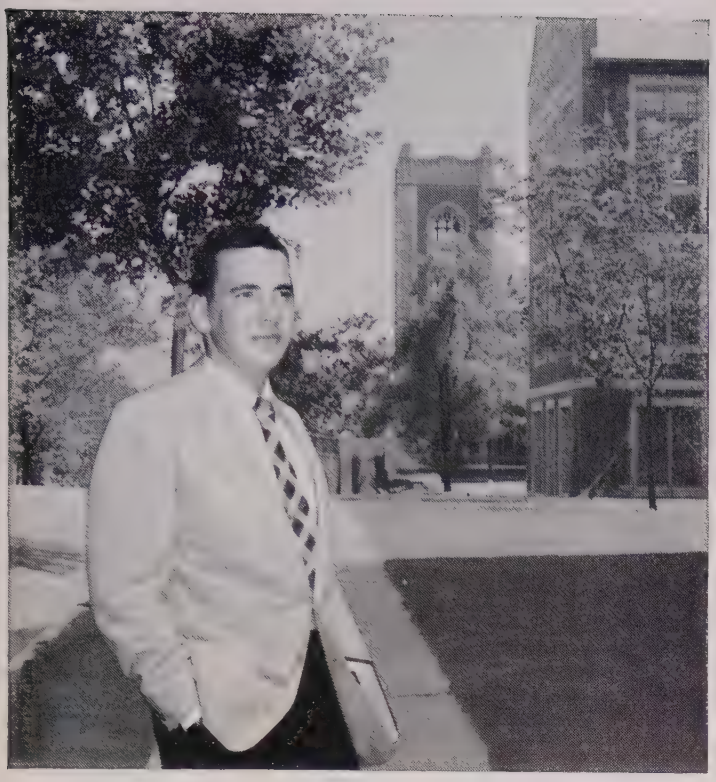

Donald W. Sundstrom received his B.S. degree in Chemical Engineering from Worcester Polytechnic Institute in 1953. He's currently studying for an M.S. degree and expects to receive it next year. Like other engineering students, he's asking a lot of searching questions before deciding on a permanent employer.

*Don Sundstrom asks:*

# What are my chances for advancement in a big firm like Du Pont?

Gerald J. Risser, B.S. Chem. Eng., Univ. of Wisconsin (1937), is now assistant manager of the Engineering Service Division in Du Pont's Engineering Department, Wilmington, Delaware.

*Jerry Risser answers:*

I THINK I know exactly what's behind that question, Don, because the same thing crossed my mind when I first graduated and looked around for a job. That was about seventeen years ago, when the Du Pont Company was much smaller than it is today. And there's a large factor in the answer, Don, right there! The advancement and growth of any employee depends to a considerable degree on the advancement and growth of his employer. Promotion possibilities are bound to be good in an expanding organization like Du Pont.

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All in all, Don, your chances of advancement on merit are mighty good at Du Pont!

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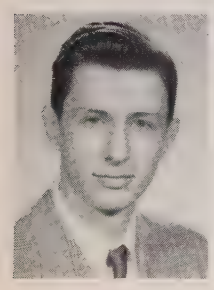
*Biography . . .*

# Omar Khayyam

by Jim Piechochi, Aero E. '56

Perhaps it was the very soul of the ill-fated Hasan Ben Sabbah, crying out in repentance of his evil life, or the victimized Oriental known as Nizam-ul-Mulk beseeching the Tartar gods for vengeance that have raised the name of Omar Hhayyam to the position that it occupies today. But fate can never be satisfied if the true credit for the fame of the Sufistic Khayyam is not placed in the hands of one minor English poet, who, after seven centuries, made famous the philosophies of the astronomer-poet of Persia. This Englishman, Edward



JIM PIECHOCHI

Jim is a newcomer to The Technograph staff on this campus. Heretofore he has periodically written articles for us from Navy Pier. We are hoping for more good work from him before he graduates in February of 1956.

Fitzgerald by name, striving to seek a connection between the ancient Persia and the Ireland of his predecessors, stumbled onto the exotic depths of Persian thought and the writings of Omar. So fascinated was he by al-Khayyam's meditations that he began a feverish study of the works of the somber Saracen of Naishapur. Six years later, in 1859, he published at his own expense a thin paper-bound pamphlet which sold for the modest price of five shillings. The printer quickly reduced the price and one year later a copy could be picked up by interested Englishmen for a penny. Many copies collected dust on bookshelves, while others were rapidly discarded, literally forced into obscurity by a flippant toss into a London gutter. Fitzgerald became no richer or poorer, nor was he raised one notch higher into national prominence. He simply remained at his same calm, unnoticed position on those broken steps that lie ever so close to the dark chasms of obscurity. Then one day a copy fell into the hands of the celebrated Dante Gabriel Rosetti, and so surprised was he by those shouting, hoping, and lilting quatrains that he carried the book with him wherever he went and quoted often from it. Burton and Swinburne spread Dante's enthusiasm and soon all of England was scouring those same dust-covered bookshelves in search of that little booklet with the now-famous title—The Rubaiyat of Omar Khayyam. This movement created one of the biggest revolutions in literature of that period. In 1929, a New York collector bought one of the original copies for eight thousand dollars. But to speak of revolutions is to speak of thoughts, and in speaking of thoughts it is very often that the thinker is discarded and separated from that which he originates. It was the rediscovery of the Rubaiyat that raised into full view that little known poet-astronomer-mathematician of mysterious Persia —Khayyam, which means tentmaker.

He was born at Naishapur in 1049 A. D. and died there in 1123. He was the son of Abraham the Tentmaker, and his full name was Omar ibn Ibrahim al-Khayyam, Giyat ed-din Abul Fath. In his youth he became the student of the aged teacher of Naishapur, Iman-Muaffak the Sufi. He studied with two friends who were destined to have a great effect on his life, and they were the Nizam-ul-Mulk and the evil Hasan ben Sabbah. All were of extraordinary intelligence and sharpness of wit, and realizing that they were the products of the wise Iman and certainly destined for good fortune, they mutually vowed that the first to achieve fame would share it with the remaining pair. After years passed, it was Nizam-ul-Mulk who reached the goal first, as he was elevated to the position of Grand Yizir to the Selpukian sultan. Alp-Arslan the Son, and his successor Malik Shah the Grandson. Omar and Hasan approached Nizam and the goodly Vizur, remembering the schoolday agreement, sealed his part in the bargain. To Hasan he bequeathed the position of Hajib, which means chamberlain. To Omar he offered a similar lofty title which the former promptly refused, accepting instead a modest annual allowance of 1200 mithkals to pursue a comfortable life of literary and scientific endeavor. Soon the ungrateful Hasan, seeking to replace Nizam in the Sultan's favor, was banished from the court screaming oaths of vengeance upon his old schoolmate. Nizam himself was banished at a great age and left at the mercy of the Ismalite Fidais, a sect of the Assasins, who attacked and stabbed him to death. Hasan had made good his revenge.

Omar, however, accepted his fate with more reserve than did Hasan. Upon the death of the Sultan Alp-Arslan, he became the royal astronomer of the court and was placed in charge of a project to revise the calendar. His mathematical observations continued and he was contented with the many hours of meditation his life afforded. His literary efforts were no doubt the outlet for his probing mind which forever busied itself not only with mathematical investigations, but also with an almost frantic search for proof of the existence of an after-life. Finding no answer to the latter problem, he settled down to an earth-bound existence which he reasoned could only be promoted by a dire effort to satisfy the senses. ("Ah, make the most of what we yet may spend, before we too into the Dust descend.") His somewhat pantheistic views were in direct contradiction of the Sufi religion, which he scorned and discarded with the wave of his hand. His freedom of thought, so vividly reflected upon in the haunting strains of the Rubaiyat, was always a matter of discussion in the court and a source of danger to his life, as the Sufi constantly tried to entrap him. Hence, al-Khayyam had a hard life, loved and respected as a scientist, and rejected and scorned as a philosopher and thinker. True enough, any analysis of Khayyam's motives will create skepticism among most men, but any study of his literary style and presentation will invariably result in his being called an expressive genius, with, of course, a silent nod and proper thanks to his collaborator, Edward Fitzgerald. But like most great artists his literature was not accepted by those of his time. "A great scientist, the Iman of Khorasan," they shouted in their courts of Justice, but speak of philosophy and they called him fool. He died peacefully in the town of his birth "sans wine, sans song, sans singer, and—sans End!"

Any analysis of Omar's mathematical achievements cannot proceed without a study of the pre-Khayyam mathematics of the Greeks and the Egyptians. The infant study of algebra was said to have originated with the term al gibr w'al mukhaba, a title occuring on every Saracen work on the subject since 825 A. D. The Egyptians, led by Ahmes (c. 1600

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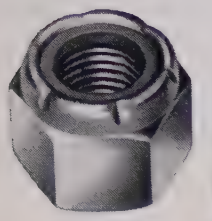

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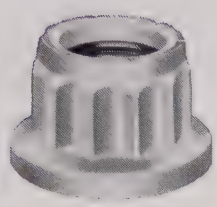

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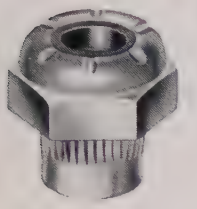

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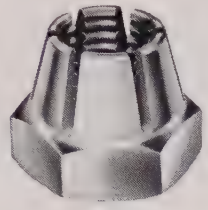

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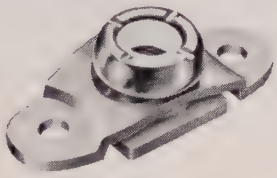

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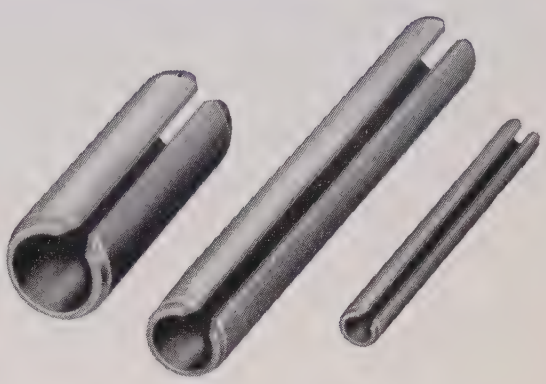

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B. C.) solved simple linear algebraic equations, while the Greeks and Hippocrates solved algebraic problems of great complexity. Aristotle (c. 340 B. C.) explained basic mathematical concepts in his many treatises on logic. Archimedes solved various word problems, including the one which baffled the Egyptians, namely, to cut a sphere by a plane so that the two segments formed are in a given volumetric ratio. The Arabians contributed heavily to early mathematical development. Mohammed ibn el-Leit interested himself with the cubic equations, the problem of trisection of an angle, and the solution of fourth degree equations which he later achieved by the method of intersection of conics. The last Arab of importance before Khayyam was al-Karkhi (c. 1020).

A vast difference is noted between Greek and Arab mathematical thought, the Greeks, with their great strides forward along the lines of abstract philosophy and all their thought seemingly channeled to exhibit their skill in deep thinking, and the Semitic Arabs with their own philosophy effecting a mathematics which mirrored their general pragmatic outlook, both paved the way for the algebra of Khayyam.

"By the help of God and his precious assistance, I say that algebra is a scientific art." So said Omar Khayyam of the study in which he excelled. Biographers have depicted al-Khayyam as a true mathematician, exceeding in certain aspects the thinking of Diophantus and Al Kwarizimi, although Omar completely abandoned the use of symbols or word abbreviations and relied on word or phrases to describe his unknowns. For example, he termed the successive powers of unknown "roots" or "sides" as "square," "square - square," "square-cube," "cube-cube," etc., and negative "sides" were called "part of root," "part of square," etc. Omar solved his equations, some of them the more difficult non-linear type, by the method of intersection of conic sections. That is to say, he formed a typical solution of the form presented and applied his solution to the problem at hand. He believed that this was the only method that could be applied to the solution of the cubic equation, which he called unsolvable by calculation. By far his greatest contribution to the science was his thorough classification of the cubic equation, often referred to by some of the later mathematicians as extremely fine pieces of work. But Omar was responsible for some classical blunders. He believed there to be no analytical method to the solution of the cubic equation he so systematically organized, and that biquadratic equations were unsolvable by geometric construction. He over-looked the fact that the cubic equation has three solutions, losing roots by using only one side of the hyperbola employed in his geometric construction. One bright feather in the Persian's hat was his solution to the age-old problem of constructing an equilaterial trapezoid whose base and sides are of some given length and whose area is given. In the solution of equations higher than the second degree he had no rival before or in his time.

Another achievement of the "big silent" Saracen which cannot be overlooked is his reorganization of the calendar. This he accomplished by order of the sultan in 1079 A. D., which is, incidentally, the beginning of an era of man's attempt to record and systematize the universe to his daily life. Omar grouped the years into cycles of thirty-three years each, giving the year 365 days, and making every fourth year a leap year of 366 days. This revision gave every cycle eight leap years with an interval of five years between the last leap year of each cycle with the oncoming one in the next cycle. This makes Omar's average year 365 days, five hours, forty-nine minutes, 5.45 seconds. Astronomically speaking, his year was 19.007 seconds too long. It is interesting to note that the Gregorian year is 25.557 seconds too long, necessitating the dropping of a leap year every 4545 years. If Omar's calendar were adopted today, one leap year would have to be omitted "only" every 3381 years—a one-third step toward perfection!

The seventy-four years of Omar's life were filled with achievement. But the years of achievement were marked by his constant soul-searching mental attitude, which, if not resplendent in his mathematics, certainly comes shining fatalistically through in his Sufistic quatrains, or rubaiyat. His search for the after-life ended in his complete abandonment of the Tomorrow in exchange for the Today, which, after all, "has outlasted so many Tomorrows." He constantly felt revoked by his dark Muezzin crying from the Tower of Darkness, "FOOLS! Your reward is neither here nor there." Perhaps it was his wisdom or his foresight which made him speak out one day to his pupils, Kwajah Nizam of Samarcand, "I desire that my tomb shall be in a spot where the north wind scatter roses upon it." This shocked Nizam for it was an intense belief that no man might know his own burial grounds. Later Lizam visited his teacher's resting place, "and lo!, it was just outside a garden, and trees laden with fruit stretched their boughs over the garden wall, and dropped their flowers upon his tomb so that the stone was hidden under them."

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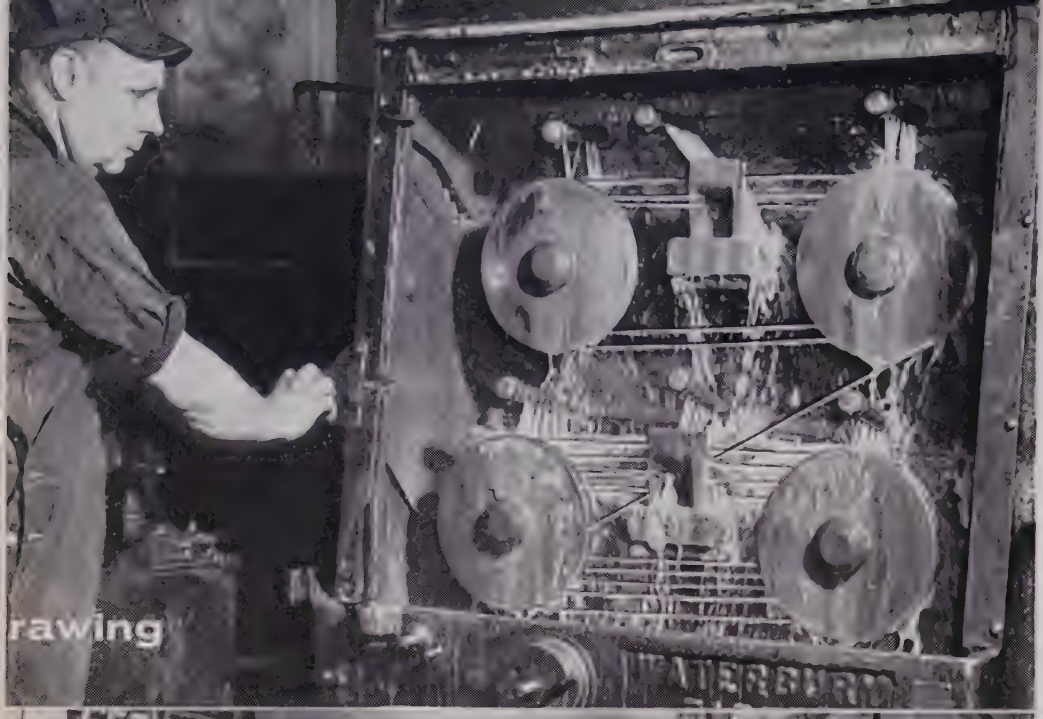


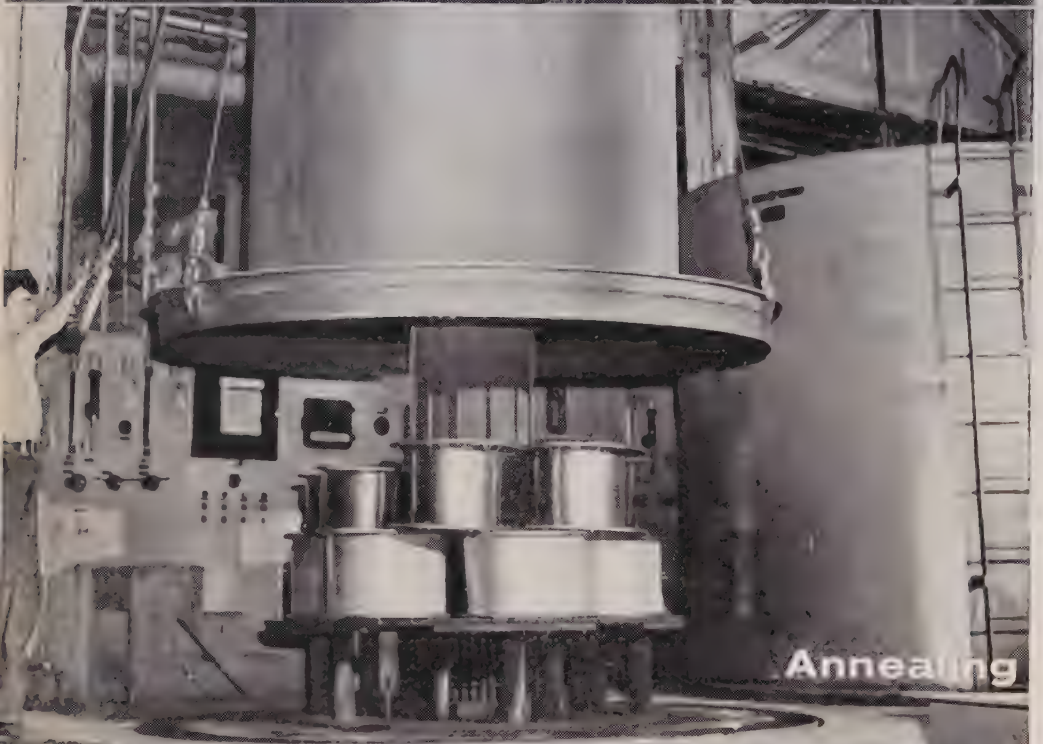

# The
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Electrical conductors for wires and cabl are generally made from either aluminu or copper. Except as noted below und annealing and metal coating, essentially th same method is used in preparing electric conductors from these metals.

## Preparation of Wires

The metal, after purification at the refiner is cast into billets about four inches squa and about four feet long. For use in electric conductors, this billet is reduced in cros sectional area to produce the flexibilit required in the finished wire or cable. Fo example, weatherproof wire for outsid power distribution, where little flexibility required, contains conductors that are soli or made of relatively few wires. For heate cord and welding cable, where excessiv flexing in service occurs, the conductors ar made up of a large number of small wire Between these two extremes there is a wid variety of cable constructions requirin numerous sizes of wires.

The reduction in area of the billet begun on the rolling mill where the billet reduced to rods, the commercial sizes which vary from about one-quarter to three quarters inch in diameter. Rods are reduce to final wire sizes by drawing through succession of dies of gradually decreasin diameter, the reduction in area per die draft being about 30 per cent.

## Drawing

The drawing of wire increases its hardnes and tensile strength and decreases its elon gation and electrical conductivity. Sinc elongation determines the ability of material to withstand repeated bending o flexing, it follows that the drawing of wir reduces its flexibility. Except where strengt is important, as in weatherproof wires sup ported aerially, practically all electrical con ductors should have greater flexibility an electrical conductivity than that provide by hard-drawn wire. Both flexibility an conductivity are improved by annealin hard-drawn wire.

## Annealing

Annealing consists of subjecting the wire i coils or on spools to a temperature of abou 650°F for about two hours. Large coils o spools may require a longer time and highe temperature. To prevent tarnishing durin the annealing of copper wire, it is neces sary to anneal in an inert (oxygen free) at mosphere. This precaution is not necessar in annealing aluminum wire. Annealing o hard-drawn wire increases its ultimat elongation about 2000 per cent and elec trical conductivity about 3 per cent.

US RUBBER

# reparation lectrical conductors

## Metal Coating

protected copper in contact with rubber ulation combines with sulphur in the in- ation to form copper sulphide. This re- ces the conductivity of the copper and kes it brittle and difficult to solder. rthermore, copper in contact with rubber, celerates the combination of rubber with ygen and hence promotes the deteriora- n of rubber insulation. To prevent this tually harmful action, copper for use in bber-insulated wires and cables is pro- ted with either a thin continuous coat- of inert metal, such as tin, lead, or d-tin alloy on the individual wires or a arator consisting of a wrap of threads or e over the uncoated conductor.

Metal coating consists of passing the in- idual copper wires successively through dilute hydrochloric acid, (b) molten tal or alloy, (c) a wiper, (d) a cooling bath d finally to a take-up reel. The hydro- oric acid cleans the surface of the copper uring a perfect union between the copper d the coating metal and a complete cov- ge of the copper by the coating metal. e wiper removes the excess coating ma- ial and produces a smooth surface on coated wire.

Metal coating or a separator is not required on aluminum conductors for rubber insulated cables since aluminum does not combine readily with sulphur and does not accelerate the deterioration of rubber.

## Stranding of Conductors

As pointed out above, the purpose of wire drawing is to so reduce the cross-sectional area of the billet or rod that a conductor of the required flexibility can be produced. In addition to adequate flexibility, the conductor must also have sufficient cross-sectional area to provide the current carrying capacity and voltage drop required for a particular application. In general, the service conditions and current carrying capacity of wires and cables are such that conductors of greater flexibility than is obtained with a single wire (solid conductors) are required. Solid conductors are used generally only on sizes 6 Awg. and smaller conductors and then only for fixed (not portable) installations. Most conductors, are, therefore, made up of more than one wire.

The formation of a conductor by bringing together the required number of wires is known as stranding, and the conductor thus formed is known as a stranded conductor. There are two fundamentally different types of stranding, namely, bunched stranding and concentric stranding. These differ in the manner in which the wires are assembled to form a conductor.

### Bunched Stranding

In bunched stranding, the required number of wires are simply twisted together with no attempt being made to control their relative positions within the group. The length of the group requiring a complete turn of any one wire is known as length of lay of the strands. The length of lay varies widely with the number and size of the wires and the flexibility desired in the conductor.

### Concentric Stranding

In concentric stranding the individual wires are laid up symmetrically in the form of a geometrically compact group. For example, six wires will lay snugly around one central wire, twelve wires will lay around a group of seven, etc. All of the wires are laid up around the same or a common center, hence the term "concentric stranding". The number of wires in the outer layer increases by six and the total number of wires in the assembly becomes 1, 7, 19, etc. The wires in any one layer are cabled or twisted around the central core with a definite length and direction of lay. The direction of lay of the wires is reversed in alternate layers to equalize the torsional forces resulting from twisting the wires about the central core. The length of lay depends on the size of the individual wires and the number of layers in the conductor.

### Rope Stranding

A modification of concentric stranding known as rope stranding is used chiefly in the preparation of large flexible conductors for portable and welding cables. This differs from concentric stranding in that a group of wires, known as ropes, instead of individual wires, are laid up in a geometrically compact form of six around one, etc. These groups of wires may be either concentric or bunched stranded. This type of stranding makes possible building up a conductor with a greater number of wires than can be produced by concentric stranding on a machine with a given number of spools.

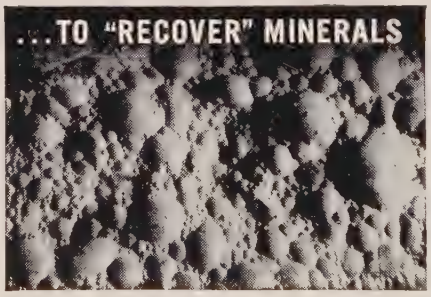
### Other Strandings

Other types of conductor strandings, such as "sector-shape", "compact-strand" and "segmental" are used for special purposes to reduce conductor diameters and conductor losses.

**WHEN FLOODS COME,** the threat to health from polluted waters is minimized by using pine oil disinfectants in clean-up operations. Pine oil disinfectants have long been recognized for their high germicidal action and good cleansing qualities. Economical to use, and possessing a pleasant fragrance, disinfectants, cleaning compounds, and soaps made with Hercules® Pine Oil are widely used in industry and the home.

# HOW HERCULES HELPS...

Most businesses are helped today by Hercules' business ...the production of synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and many other chemical processing materials—as well as explosives. Through close cooperative research with its customers, Hercules has helped improve the processing or performance of many industrial and consumer products.




**THE FLOTATION PROCESS** is used extensively in industry to separate fine particles of valuable minerals, ranging from coal to gold, from less useful materials by floating to the surface and removing in a froth formed by air bubbles. Hercules flotation agents, Yarmor® Pine Oil, Rosin Amine D Acetate, and others, serve as frothers or collectors in this job.

**DESIGNED TO PROTECT** industrial equipment, from the time it leaves the factory, lacquer is outstanding. When necessary, re-finishing can be done quickly and economically because of lacquer's fast-drying, fast-taping properties. As a major supplier of nitrocellulose to lacquer manufacturers, Hercules has available a wealth of technical information on lacquer and its many uses.

G54-9

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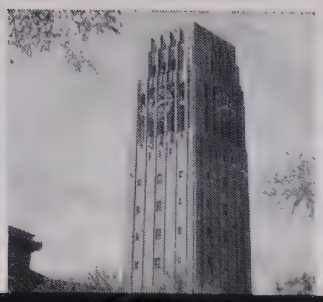
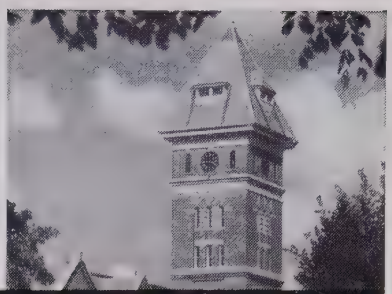


MICHIGAN

IOWA STATE



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This year and every year we'll be visiting these same nine schools—looking for additional electrical, mechanical, industrial and general engineering talent. We'll interview hundreds of men to get a dozen. The standards are high—the opportunities great. Why not let us tell you more about Square D and what we have to offer?

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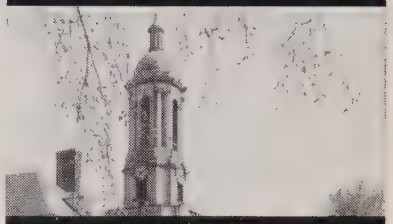
ILLINOIS



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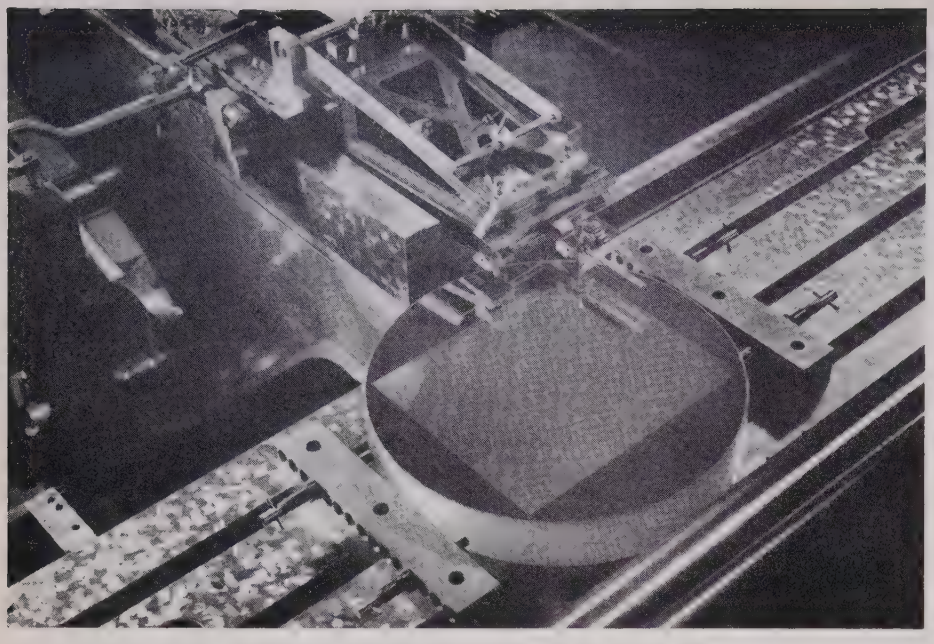


A large finished grating in position at end of ruling cycle. The complex mechanism of the diamond carriage is shown. (All photos courtesy Bausch & Lomb Optical Co.)

Some of the earliest diffraction gratings were made by Joseph Fraunhofer (1787-1826). They were constructed of fine wires .04 to .06 mm in diameter and spaced .0528 to .6866 mm apart. Modern diffraction gratings are made by ruling lines on metal or glass with a diamond point.

The problem of ruling a large number of straight, equally spaced, parallel lines is a difficult one. Fraunhofer (1821), Nobert (1846), and Rutherford (1870) were among the first to rule small gratings. Rowland at Johns Hopkins University was the first to rule high quality gratings. At the present time only Johns Hopkins University, Mt. Wilson Observatory, and Bausch & Lomb Optical Co. are capable of producing gratings 100mm or more in width.

High resolving power is maintained by holding the spacings of the grooves to within .01 microns. (A micron is .001 mm.) Extreme precautions are taken to insure this accuracy. The gratings are made in a special underground lab-

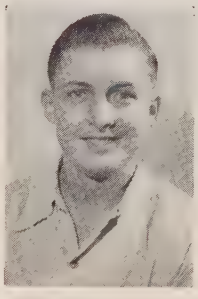
## Another Rainbow . . .

# DEFRACTION GRATINGS

by Larry Kiefling, M. E. '56

When a light wave moves past a corner, the corner acts as a source of light and the light seems to bend around the corner. This phenomenon can be observed only when the dimensions of the corner are comparable to the wavelength of the light and when the source of light is small.

If a large number of edges or slits are placed close together, the light from each of these will interfere with the light from the others and form an interference pattern. If the slits are equally spaced, the interference lines for a given color will be parrallel to each other and can be focused by a lense or mirror to form an image of the slit. This arrangement of many equally spaced slits is known as a diffraction grating. The various colors of light will interfere at different angles and form a spectrum. Diffraction gratings produce a series of spectra which are numbered in their order from the center. The spectra produced by diffraction gratings are known as rational spectra because the sin of the displacement angle is proportional to the wave length of the light.



LARRY KIEFLING

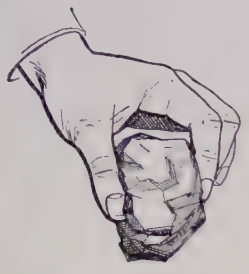
Larry is a junior in Mechanical Engineering from Cowden, Ill. He is a member of ASME, and Phi Eta Sigma, freshman honorary.

oratory such as the one shown. The temperature of this laboratory has been held within .01°C for periods of over two weeks. The maximum vibration of the ruling engine is .025 microns.

The engine shown was built by Michelson, rebuilt by Gale, and presented to Bausch & Lomb by the University of Chicago. The engine is capable of ruling gratings up to 150 mm in length and 300 mm wide. However, more work must be done on the machine before this full area can be used. At present the largest gratings ruled are 153 x 203 mm. Gratings ranging from 60 to 2,160 grooves per mm are ruled! The precision screw has been studied and a brass cam cut to exactly correct the error. Engraving is done with a carefully shaped diamond point. The diamond

# QUARTZ CRYSTALS

## *How a 1¼ hour "gem-cutting" operation became an 8-minute mechanized job*



**PROBLEM:** Preparing quartz crystals for use as electronic frequency controls calls for the highest degree of precision. So much so, in fact, that prior to World War II skilled gem-cutters were employed to do the job.

But during the war, there were not enough gem-cutters to keep up with the demand for crystals in radar, military communications and other applications.

Western Electric tackled the job of building into machines the skill and precision that had previously called for the most highly skilled operators.

**SOLUTION:** Here is how quartz crystals are made now—by semi-skilled labor in a fraction of the time formerly required:

A quartz stone is sliced into wafers on a reciprocating diamond-edged saw, after determination of optical and electrical axes by means of an oil bath and an X-ray machine. Hairline accuracy is assured by an orienting fixture.

The wafers are cut into rectangles on machines equipped with diamond saws. The human element is practically eliminated by means of adjustable stops and other semi-automatic features.

The quartz rectangles are lapped automatically to a thickness tolerance of plus or minus .0001". A timer prevents overlapping. Finally, edges are ground to specific length and width dimensions on machines with fully automatic microfeed systems.

Most of these machines were either completely or largely designed and developed by Western Electric engineers.

**RESULTS:** With skill built into the machines —with costly hand operations eliminated— this Western Electric mechanization program raised production of quartz crystals from a few thousand a year to nearly a million a month during the war years. This is just one of the many unusual jobs undertaken and solved by Western Electric engineers.

*Quartz stones are cut into wafers on this diamond-edged saw, with orientation to optical axis controlled by fixture. This is just one of several types of machines designed and developed by Western Electric engineers to mechanize quartz cutting.*

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; Haverhill and Lawrence, Mass.; Lincoln, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 15 cities. Company headquarters, 195 Broadway, New York City.

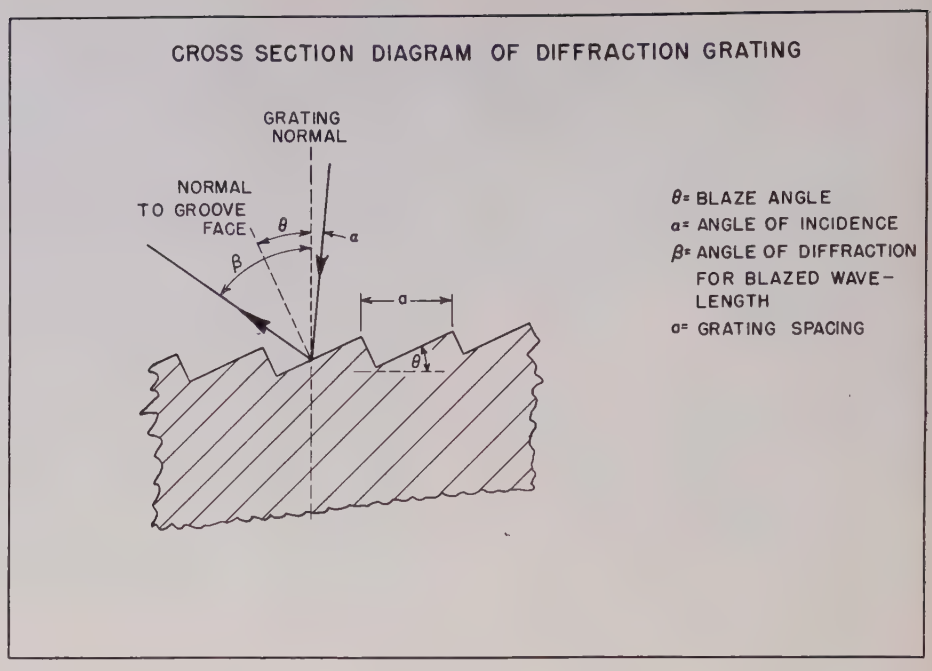
carriage is carefully designed and built to give the same straight line motion with each stroke.

Master gratings are ruled on blanks of borosilicate crown glass coated with a heavy layer of vacuum evaporated aluminum. The actual ruling of a master grating is a long slow process. Adjustment and orientation of the ruling diamond may take more than a day. Twenty five points on the engine must be checked, lubricated, or adjusted. The engine is allowed to run for 18 or 20 hours to allow it to come to its final operating temperature. The normal ruling speed is 10 strokes per minute or 600 per hour. On a grating with 600 grooves per mm, the rate of ruling is 1 mm per hour or about 1 inch per day. A wide variety of tests are run on the finished gratings to see that they meet all specifications.

Much work has gone into the development of a process for the manufacture of a diffraction grating which maintains the quality of the master grating. The following process is used by Bausch & Lomb for making their "Certified Precision" gratings. The grooves are formed in a thin layer of plastic which adheres to a glass backing plate. The plastic is not subject to deterioration but is easily damaged by wiping, brushing, or touching the surface. Reflectance gratings are coated with aluminum. This coating can be renewed if the aluminum becomes stained. Transmission gratings can be used only in the regions of the spectrum where glass is transparent.

The number of grooves per mm or its reciprocal, the grating constant is of great importance in determining the properties of a grating. The groove width must not be less than the longest wave length to be studied. The grating acts chiefly as a reflector for longer wavelengths. This property is useful where it is desirable to separate visible light from infrared by the use of fine diffraction gratings for the infrared.

The first order angular dispersion of a grating is directly proportional to the number of grooves per mm. It is possible to get greater dispersion by using a grating in a higher order or by using lenses of a longer focal length to get a larger grating to spectrum distance. There is an upper limit of about 900 grooves per mm for practical transmission gratings. This is because that light cannot escape from the groove face at an angle exceeding that of the groove face.

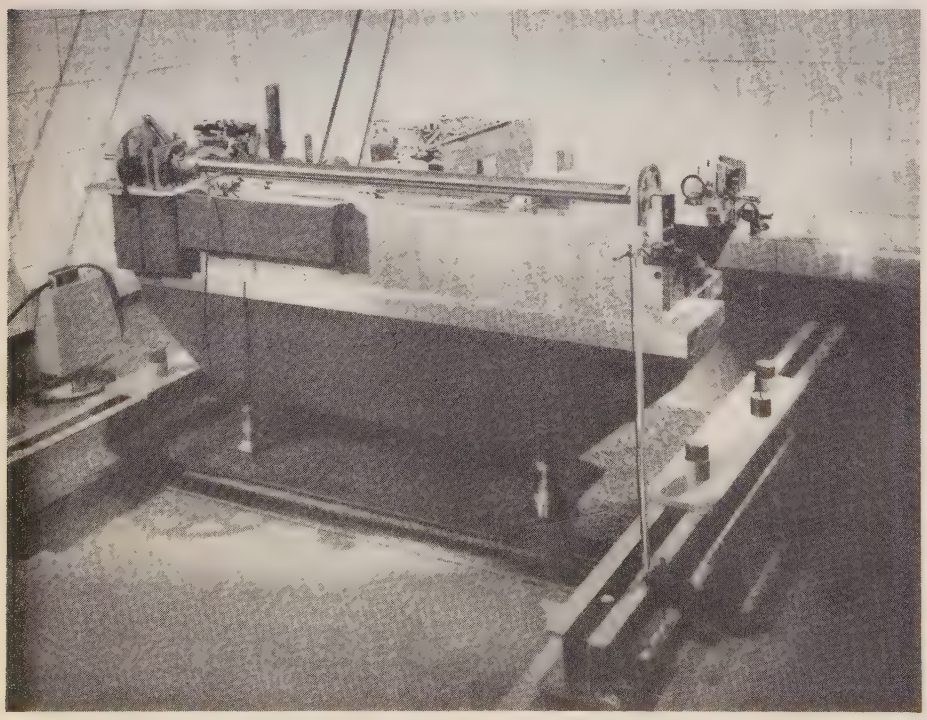



Profile view of a reflectance grating. Transmission gratings have the same shape.

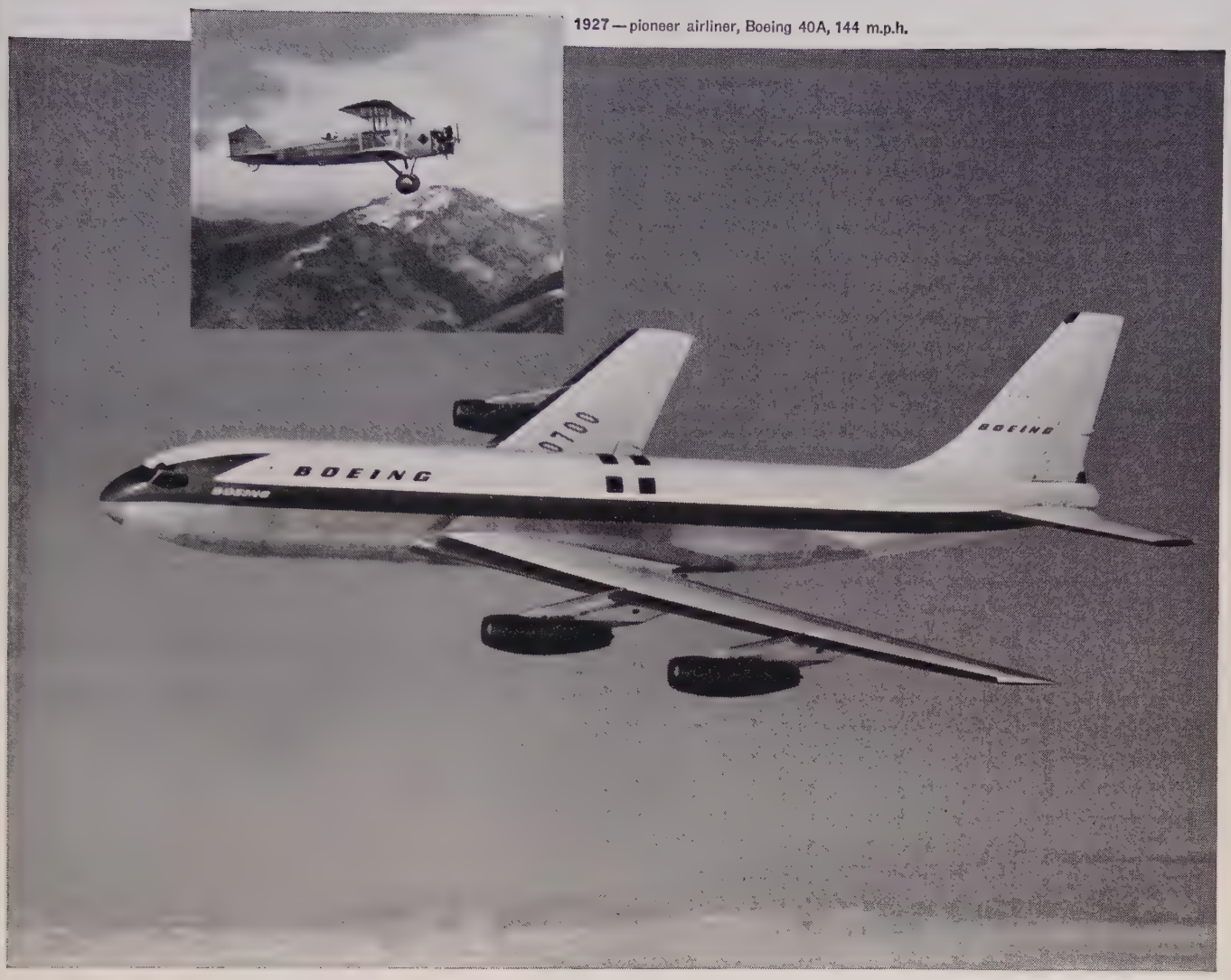
Modern diffraction gratings are blazed by controlling the groove face angle so as to concentrate the spectral energy in the desired region of the spectrum. The wanted angle is found by using the wavelength at the center of the desired region and calculating the groove face angle for which the specularly reflected light will have the same angle as the diffracted light. Gratings ruled with grooves should have two different blazed regions, one on each side of the zero order. The gratings are usually designed with a relatively small angle on one side for use in the first or second order spectra and a steep side which can be used for high order work. This makes it possible to use the same grating for a wide variety of work.

The blaze angle of reflectance gratings is calculated from the fact that the angle of reflectance is equal to the angle of incidence. The blaze angle in transmission gratings is calculated on the assumption that the angle of incidence is mormal to the ruled surface and that the ray passes thru the glass and emerges from the ruled surface. The blaze angle for a transmission grating is the groove face angle that refracts the transmitted light of the blazed wavelength at the angle of diffraction for that wavelength.

Rowland ghosts are caused by periodic



The Michelson-Gale ruling engine. Gratingswith up to 2,160 rulings per mm. can be made.




1927—pioneer airliner, Boeing 40A, 144 m.p.h.

1954—America's first jet transport, the Boeing Stratoliner, 550 m.p.h.

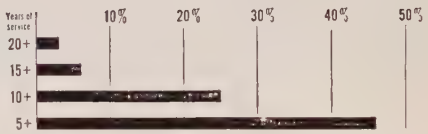
# Two trail-blazing transports . . . both Boeings

America's pioneer transcontinental airline passenger plane, the 40A of 1927, was a Boeing. Today, America's first jet transport is another Boeing, the 707. This quarter-century of commercial design leadership is paralleled by military design leadership ranging from the old B-9 bomber to the fighter-fast Boeing B-47 and B-52 jet bombers of today.

For 38 years Boeing engineers have blazed exciting new trails in design, research and production. They're blazing them today in jet aircraft, guided missiles, and research in supersonic flight and the application of nuclear power to aircraft.

If such new-horizon engineering appeals to you, Boeing offers a rewarding career, whether you are in civil, mechanical, electrical or aeronautical engineering, or a related field. Boeing is expanding steadily, and employs more engineers today than even at the peak of World War II. Boeing also promotes from within, and holds regular merit reviews to give you individual recognition.

At Boeing you'll find an unusual range of opportunity, from applied research to production design, from work with new materials and techniques to contacts with a cross-section of industry through the company's vast subcontracting program. Boeing employs draftsmen and engineering aides to handle much routine work, thus freeing engineers for more stimulating assignments.




Boeing engineers enjoy stable careers —46% having been with Boeing for 5 years or more; 25% for 10, and 6% for 15. Many engineers have been here 25 years, and 7 have been with Boeing for 30.

Boeing helps engineers continue their graduate studies, and reimburses them for tuition expenses.

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**Boeing Airplane Company, Seattle 14, Wash.**

**BOEING**

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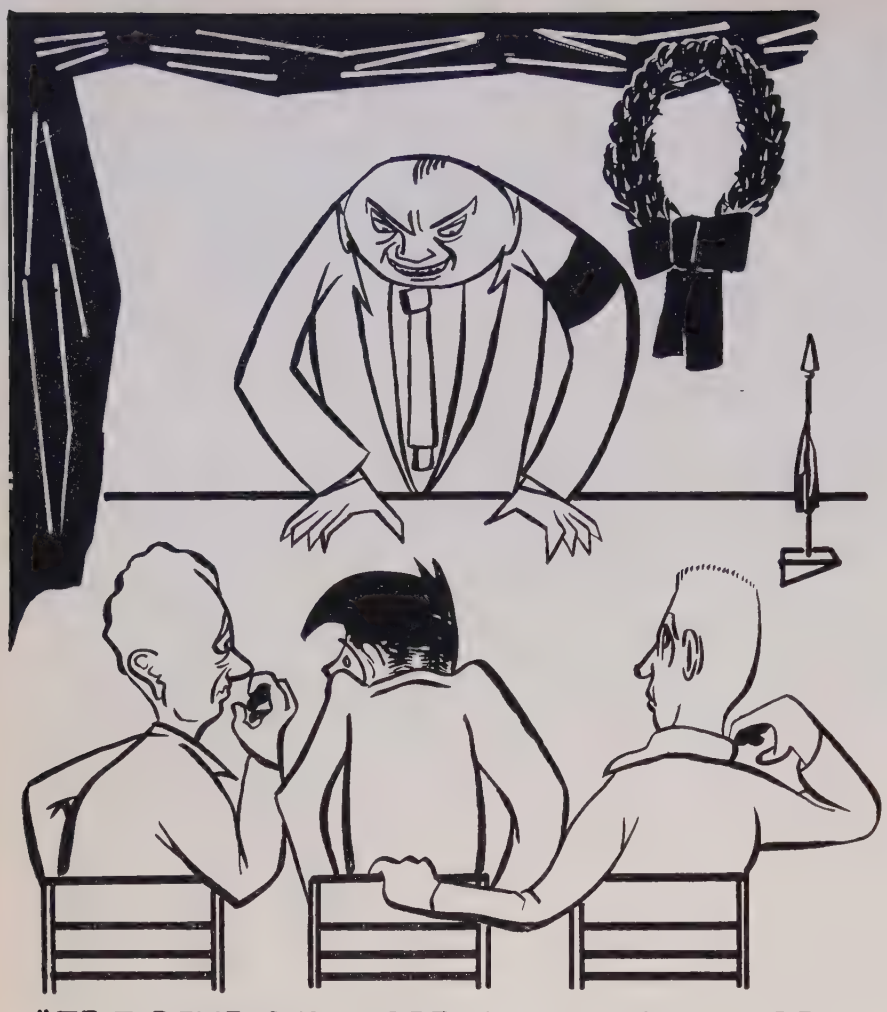
# THIS IS

by

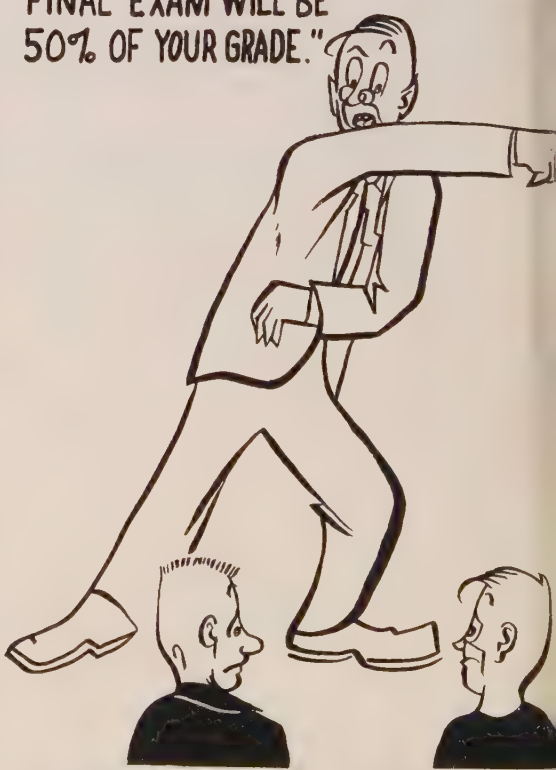
Dave Tempest



"IF I REMEMBER CORRECTLY, I SAID THERE WOULD BE AN EXAM TODAY."

"GET AN EDUCATION! DON'T WOR
ABOUT MARKS - BY THE WAY, YOU
FINAL EXAM WILL BE
50% OF YOUR GRADE."

"NO EXCUSES! YOU KNOW I DON'T TOLERATE TARDINESS!"



"THAT LI'L OL' ALARM CLOCK - HA! HA! - GOES BAD SOMETIMES..."

"REMEMBER, T.V. IS BAD FOR STUDIES
BLAST OFF, RANGERS! - ER - CLASS DISSMI

# OLLEGE?

'S NOTHING, REALLY. JUST A NEW GRADING CURVE I'M USING - EVERYBODY FLUNKS!

ENSHAW, LET'S STICK WITH THE LAB MANUAL, HMMMM?

"IT'S SO NICE OF YOU BOYS TO HELP ME TO MY OFFICE. HOW FOOLISH OF ME TO FORGET MY GLASSES."

THIS GENERATION! IRRESPONSIBLE! UNINTELLIGENT! WHY EVEN YOUR SLANG HAS REACHED A NEW LOW!

HEY, REF! YOU VACUUM HEAD! YOU SHMOE! GO! GO! YOU CRAZY TEAM! CLOBBER THEM!

## Welded Steel Designs Cost Less Because:

1. Steel is 3 times stronger than gray iron.
2. Steel is 2½ times as rigid.
3. Steel costs a third as much as iron.

**Ultimate savings are limited only by the ingenuity of the designer.**

# IMPROVES APPEARANCE SIMPLIFIES PRODUCTION CUTS COST

YOUR success as a designer depends on your ability to keep costs down on products you design. By properly applying the principles of welded steel construction, cost of manufacture can be reduced substantially because material costs are less, actual production is simpler. In addition, the product is stronger, more rugged, has modern appearance.

The examples show how one designer has applied the principles of welded steel to a machine base. The sturdy box-type construction of the steel design eliminates weight because of steel's greater strength and rigidity. Considerable machining, cleaning and finishing of former castings has been eliminated. More modern in appearance, nevertheless, the steel design costs 15% less to produce.

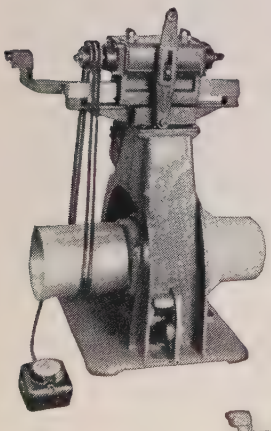


**Fig. 1—Original Design** *of wire straightening machine. Required considerable machining, cleaning and finishing prior to painting.*

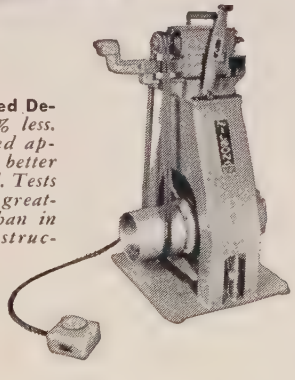


**Fig. 2—Welded Design** *costs 15% less. Has improved appearance . . . better selling appeal. Tests show base has greater rigidity than in original construction.*

### IDEAS FOR DESIGNERS

Latest data on designing machinery for welded steel construction is available to engineering students in the form of bulletins and handbooks. Write:

**THE LINCOLN ELECTRIC COMPANY**
**Cleveland 17, Ohio**

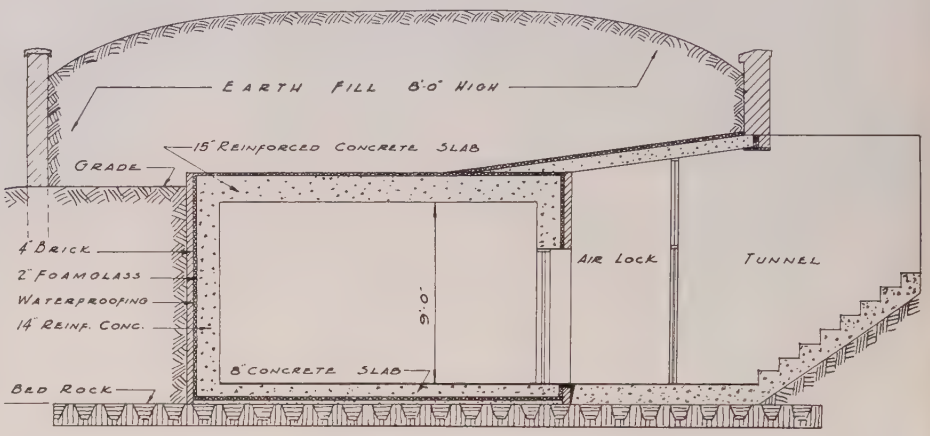
**THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT**


error in the spacing of the grooves. Even the best precision screw ever made has a small amount of error that will produce ghosts. The error may result from inaccuracies in the screw itself or from improper operation of the bearings. Rowland ghosts appear as pairs of lines on each side of the parent line. Their position depends on the wavelength of the parent line and the number of grooves in each period of error. The intensity of the ghosts is proportional to the equare of the error and to the square of the order. Thus, the third order ghost is nine times as intense as the first order ghost.

Satillites are misplaced lines in the spectrum occuring very close to the parent line. They are caused by a small number of misplaced grooves in a localized part of the grating. If there are only one or two, they can usually be masked off.

The resolving power of a grating is a measure of its ability to separate two lines with a very small wavelength difference between them. High resolving power is achieved by freedom from satellites and through the use of high quality blanks. High quality lenses, mirrors, slits, and prisms must be used. Thermal air currents and vibration of the apparatus must be controlled to get high resolving power.

Usually, diffraction gratings are used in parallel light. A collimator lense or a concave mirror is used ahead of the grating while a similar arrangement is used following the grating. Mirrors are used to advantage when the system must be achromatic and when the work must cover a large spectral range.




**Underground laboratory for ruling gratings. Extreme precautions are taken to avoid vibrations and to assure constant temperature.**

---

Small Son: "I'm not afraid of going to the hospital, mother. I'll be brave and take the medicine, and do everything they ask me to—except I'm not going to let them palm off a baby on me, like you did. What I want is a pup."

Shortly before the invasion started, a general and his staff were watching a troop-carrying glider go by. From it came a carrier pigeon. Powerful field glasses followed the bird to a near-by field. A colonel raced over, got the bird, took the message from his leg, raced back, and breathlessly handed it to the general. He opened it with trembling hands, read it, cursed, and threw it on the ground. Then he walked away, his face a bright purple. The colonel waited a moment, then picked up the message. It read: "I have been sent down for being naughty in my cage."

* * *

Coed: "What wonderfully developed arms you have!"

Guard: "Yeah, I'm on the squad. By the way, were you ever on the track team?"

The colonel was lecturing a class of incipient officers. "A forty-foot flag pole has fallen down," he said. "You have a sergeant and a squad of men. How do you erect the flagpole again?"

The candidates thought, then made suggestions about block and tackle, derricks, and so on.

"You're all wrong," said the colonel. "You say: 'Sergeant, get that flagpole up.'"

* * *

Prof: "Why aren't you taking notes?"

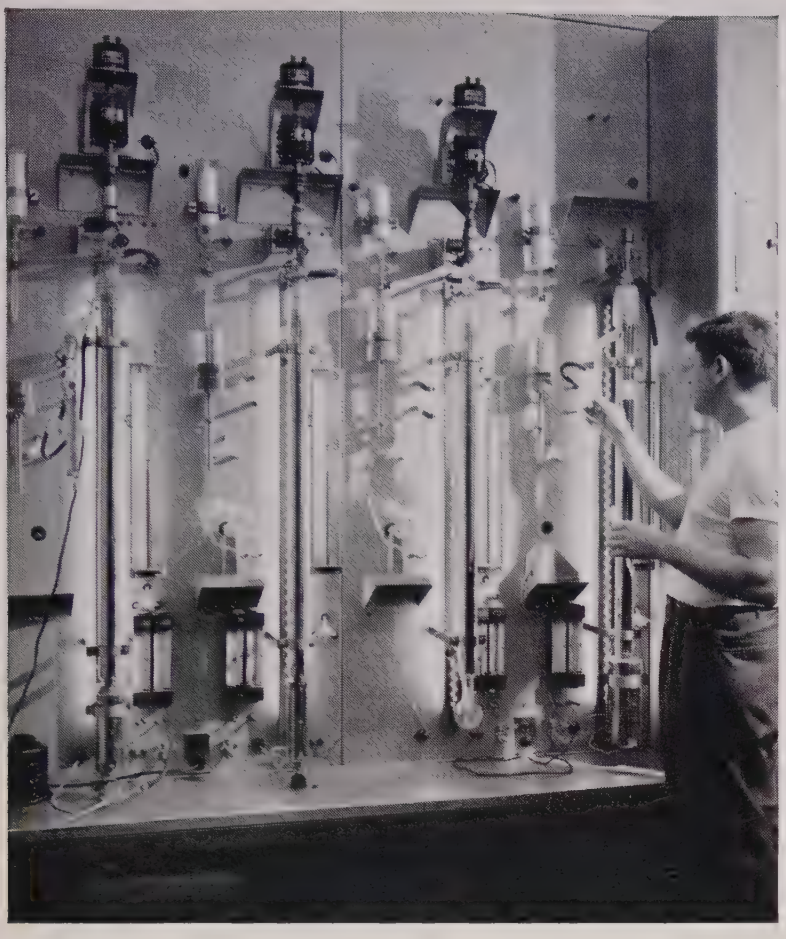
Student: "I don't have to. I've got my grandfather's."

* * *

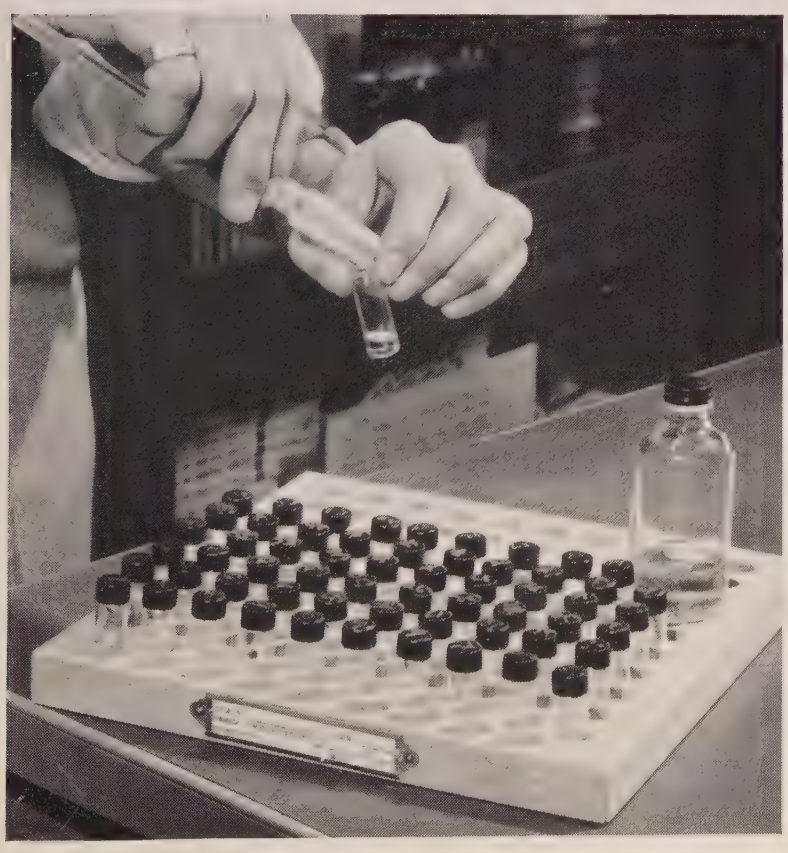
An engineer is a guy who is educated in the art of developing new and different ways of making the same mistake.

* * *

A young man whose father had been hanged was filling out a college application. After the usual hereditary questions there was one asking the cause of the death of his parents. He thought awhile and finally put down this answer: "Mother died of pneumonia. Father was taking part in a public ceremony when the platform gave way."



A laboratory assistant (above) takes a fraction from one of the new miniature stills at Standard Oil's Whiting laboratories. The small charge in the large bottle (below) can be separated into 60 fractions in these exact stills.



# NEW MINIATURE STILLS

## Valuable Laboratory Aids

Some stills in oil refineries are gigantic devices which process 30,000 barrels of petroleum a day. Others are so small—and so exact—that they may take more than a week to distill five ounces of liquid.

Scientists at Standard Oil's Whiting laboratories now are working with eight new miniature stills so precise they are considered the finest of their type in the world. These stills, installed last year, are used to study liquids produced during research on such things as aviation gasoline, synthetic lubricants and detergents, plastics and plasticizers, and petrochemicals.

Laboratory men often work with only an ounce of liquid which may be made up of hundreds of different chemical compounds. Technicians usually wind up with individual "fractions" of about 1/50 of an ounce to be examined with mass and infra-red spectrometers, chromatography and other aids.

Another new research still at Standard Oil's Whiting laboratories has a packed column one inch in diameter and 16 feet high. It is probably the most efficient packed column ever built.

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# SALTIER SAILORS

by H. V. Krone

On Sunday morning, November 16, 1947, I had my first look at the U. S. S. Canisteo, A. O. 99, a 25,000 ton navy oil tanker, aboard which I was to report for duty. The Canisteo was tied up at one of the piers in Philadelphia Navy Yard where she had just spent several weeks in dry dock. Although the ship was still relatively young, having been commissioned late in 1945, she was, nevertheless, considered to be one of the "saltier" ships of the navy, due to the fact that she had been a part of the last big Antarctic expedition. I was to find out later that the crew was equally as "salty," all of them being bonafide "Shellbacks," a status which can be attained only by sailing across the equator. Each carried a certificate to the effect that he was qualified for "spitting into the wind," and possessed various other talents which are peculiar to the "Shellback." I had gotten quite a complete story on the Canisteo from an ex-crew member whom I had met on the train ride from Norfolk Naval Receiving Station where I had been waiting for a duty assignment.

Early on the morning of November 17, the Canisteo pulled away from the Philadelphia pier and moved down the Delaware River heading out toward the Atlantic—my first cruise! It was rather short, however, as three miles down the river the ship tied up at a small island called "Fort Mifflin" where all hands worked up a nice sweat loading ammunition for the 40mm, 3 inch, and 5 inch guns.

My particular job aboard the Canisteo was maintenance of the electronic equipment, and my indoctrination into this job was not long in coming. About two hours after leaving Fort Mifflin, the P. A. system blared out my name requesting, rather forcefully, that I report to the bridge. I was shown into the radar room where I saw, for the first time, an S. U. type surface search radar set. The executive officer, who had shown me in, explained that the set wasn't working correctly and left with the words "fix it." The next several minutes being highly unsuccessful on my part, the other technician aboard, Charley Hays, who like myself was just out of the navy's one year training course in electronics and with no practical experience, was invited to join me in the effort. It was soon apparent that two green technicians were no better than one. To add to our misery, the ship had passed out of the Delaware into the Atlantic, and the roll of the ship gave us anything but a comfortable feeling. Around 2200, the electrical power system went out, including the auxiliary power unit, giving us a much needed excuse for giving up on the radar and turning into our bunks.

At reveille the following morning I was quite surprised to discover that we were tied up to a pier again, and even more surprised when I learned it was a pier at Norfolk Naval base, where I had left not too many hours before on a long train ride to Philadelphia. But this I passed off as just another example of Navy efficiency. The plan of the day here was the taking aboard of food supplies with an extra item—the repair of the S. U. radar. The solution to the radar troubles, we found was really very simple. It took only a Chief Machinists Mate, who had observed an S. U. being repaired, to suggest that we try changing the magnetron. This we did and the set worked perfectly. We were both relieved and embarrassed.

On November 19, the Canisteo left Norfolk—destination Bahrein, Arabia. This was what I had been looking forward to since the day of enlistment—travel, adventure, romance, etc. I soon found out, however, that there was a a great deal of work concerned in running a ship. The Canisteo, like most of the Service Force ships, was badly undermanned, and so Hays and I were forced into taking our share of the radar watches as well as maintaining it and all the other electronic equipment aboard. In the first few days, we became very well acquainted with the S. U. radar. At times the maintenance hours were almost as great as the operation hours. We became very proficient at trouble shooting. We were having more difficulty, however, in keeping control of our stomachs. The Atlantic was keeping it's reputation of being a rough sea, and the tanker, being empty, was riding the swells like a huge cork. I was advised not to miss the regular meals, if I was to avoid sea-sickness, so I ate heartily each time although generally with difficulty. Meanwhile Hays and I were watching each other to see who might have the first laugh. An incident during work on the radar decided that point. Hays had unwisely volunteered to go for a spare part which was needed at the moment. The spare parts were stored, in a disorderly fashion, many boxes deep in a rather small compartment. As is usually the case, the part needed was in a box near the bottom of the pile. A quick shift of a few boxes and a modified handstand, was the quickest way to the part. It also meant a quick trip to the rail for Hays where he lost one good navy meal and a little blood. I felt too sorry for him to laugh.

On November 24th, the ships orders were changed by radio. We were to go to Ras Tenura instead of Bahrein. The change was minor as both Bahrein and Ras Tenura are situated on the Persian gulf on the east side of Arabia. The complete trip was to take us through the Mediterranean, down through the Suez canal, the Red Sea, around the southern tip of Arabia, and up into the Persian Gulf.

On November 28th, Cape Trafalgar, near Gibralter became visable. This, according to Lt. Charles, a reservist on cruise who seemed to know history very well, was where the famous Admiral Nelson beat the combined French and Spanish fleets in 1805, getting himself thoroughly killed in the process. Lt. Charles, I might add, possessed a sparkling wit and good talent for writing. These he put to use, to the enjoyment of the whole crew, as feature writer for the "Oily Rag," the ship's newspaper. The "Oily Rag," whose slogan was "covers the Canisteo like the rust," featured news picked up by the radiomen, weather, occasional editorials by the Captain, "letters to the editor," and humorous articles by Charles, written mostly about the "goings on" around the ship. The "letters to the editor" were obviously also a product of the Charles wit. A typical letter, with answer, would read like this:

> Sir:
>
> I have suffered a nasty sprain of the wrist while strumming my guitar in the line of duty. How much convalescent leave may I expect when we reach the States?
>
> S—Purple Heart.

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Ans.:

Counting brig time of 3 months, I would judge about 90 days.

Needless to say, the paper was heartily enjoyed by the crew.

The plans were for a two day stop in Gibraltar. We entered the gulf of Algeceras and steamed in toward the "Rock." On the port side was the winter resort town of Algeciras and off to the starboard the "Rock" which has been the key to British control of the seaways for over 100 years. Two sidewheel tugs, which could have been refugees from the days of Mark Twain, escorted us to the quayside at Gibraltar Naval Base.

Since liberty for the crew was handed out on a two section basis, I was both surprised and happy to see my name on the shore patrol list for the first night. Here was an opportunity to go ashore two evenings instead of one. Six enlisted men and two officers made up the S. P. force, and our job, of course, was to keep the liberty section out of trouble. In order to accomplish this, it was necessary to go wherever the crew went—not at all a dull assignment. We, of course, anticipated no trouble from our own crew. After a rather brief sightseeing and souvenir buying tour, most of the crew were ready for the more interesting pursuits. I had been 9 days without so much as a cold beer for them. Gibraltar featured a wide variety of bars and nite clubs, the most popular spots being the Arizona bar and the "Wintergardens" dance hall. The greater part of the crew settled in the "Wintergardens" which featured ten lovely hostesses who danced and drank with the guests. The crew, in general, was behaving in a gentleman-like manner and this business of being a shore-patrolman seemed to be one of just watching them have a good time. This I found to be sadly untrue however, as on a routine check from the "Arizona" bar to the "Wintergardens," we stepped inside just in time to see "Flags," the big six foot signalman, down on all fours, peering delightedly up at one of the hostesses, pointing, and yelling, "Look!", "No skivvies!", "No skivvies!" Although the crew was enjoying the whole situation, the management was a little unhappy and insisted, rather strongly, that "Flags" leave. So we led him outside, convinced him he had had a few too many, and obtained a solemn promise from him that he would go back to the ship. It turned out that we were a bit too gullible however, entrusting him to go back, as approximately twenty minutes later we found "Flags" two blocks up the street in a big rhubarb with two husky British M. P.'s. It seems that "Flags" had been violating a local ordinance which forbids drinking in the streets and when the M. P.'s intervened, was loudly shouting his contempt for all the "dirty, yellow, limies." This time three of us went all the way to the ship with "Flags."

Liberty for the second section was granted after a stern lecture from the "exec," and passed without notable incident. On November 30th, we moved out of Gibraltar harbor in the middle of a roaring westerly gale. The rough weather didn't last, however, and soon it was smooth sailing in the Mediterranean with the crew once again settled down in the routine work of running the ship. Another edition of the "Oily Rag" was published and among the "letters to the editor" was the following:

Sir:

I would like to check a story I heard during our last liberty—are there still apes on the Rock of Gibraltar?

S—Nature Lover

Ans.:

According to the MAA's report, all hands returned on time and sailed with the ship as scheduled.

Also appearing was the following article:

Are we Asiatic or is this a sandstorm 160 miles at sea? First point not settled; but it is a sandstorm direct from the Sahara.

Radar indicates island of Malta still afloat to southward in spite of tough pasting from Axis bombers throughout World War II.

On December 7th, we arrived at Port Said. We stopped long enough to take aboard an English pilot, and, I suppose, make financial arrangements with the British. I was amazed to learn that there was a "slight" fee of $15,000 for passing through the canal empty and $75,000 for a ship with full cargo. But on the other hand, I could see how the digging of a ditch of that size might be rather expensive.

There were plenty of interesting sights along the Suez and cameras were kept busy. Huge bomb craters along the canal were reminders that there had recently been a bitter war fought here. Africa Corps prisoners were now busy repairing the canal banks. Camels—not really camels, but their one-humped cousins, the Dromedaries—were numerous. Arabs in their small fishing boats along the canal were quite indignant at being disturbed and one stood up shaking his fists at us after almost being capsized by the huge wake kicked up by our big bulging tanker. Top speed through the canal was supposedly 8 knots, which we observed only when passing the British check stations that appeared periodically along the "ditch." We passed through several small lakes, which the canal's builder, De Lesseps, had apparently taken advantage of to lessen the task of construction. An interesting observation of the design of the canal is the numerous bends which were purposly included to keep the tides from rushing through and washing away the banks.

After approximately 14 hours of canal travel, we entered the Gulf of Suez at the southern end of the "ditch." Here we dropped our English pilot and entered the Red Sea. Shortly we were sailing over the part of the Red Sea where the Israelites, of biblical history, crossed in their flight from Egypt. Visible on the eastern shore was Mt. Sinai, where Moses went up and came down with the Ten Commandments. Soon the Red Sea widened out and the Gulf of Akabah joined in. And here, once again according to Lt. Charles, is where King Solomon's Task Force sailed from Elath for Ophir when he was in quest of the Queen of Sheba. On December 10th, we passed through the straits at the southern end of the Red Sea. The straits are known as "Bab-el-mandeb," which is Arabic for "Gate of Tears." Here a lot of small craft have smashed up due to rocks and tricky currents.

On December 11th, Aden appeared on the port side. Aden, the historic gateway to the east, is situated on the edge of an extinct volcano. From Lt. Charles we learned that Aden was once the meeting and market place for East and West when overland trade routes were the only ones in business. Vasco DaGama put them out of business by sailing around the Cape of Good Hope and established the all-water route. The town died but came to life again when the Suez canal made it strategically important.

On December 12th, we see from the navigators charts that we are passing the Hejaz mountains which are 11,000 feet high and the highest in Arabia. Three days more sailing and we dropped "the hook" at Ras Tenura in the Persian Gulf. This port of our destination was anything but impressive. Other than the numerous oil derricks and tanks, the only thing visible was sand and more sand. Fortunate for the crew however, the skipper was a man with foresight and a great concern for the morale of his men. Almost immediately upon arrival, motor launches were put over the side, and a goodly quantity of beer from the ships refrigerators lowered into the boats. Although drinking in any form

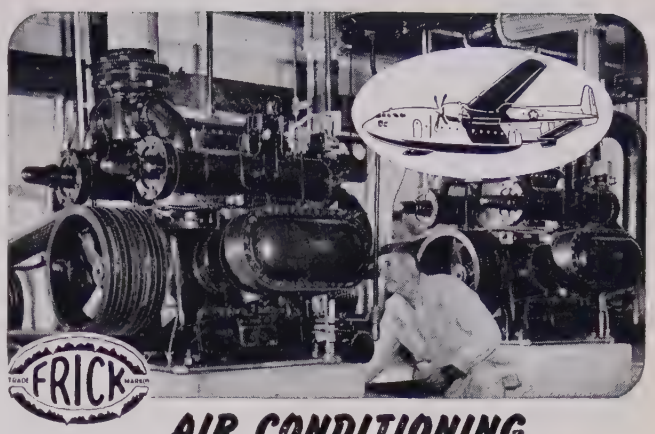
is strictly forbidden aboard ship, there is no law against beer on the beach. So, joyously, swimming and fishing parties from the first liberty section were off in the motor launches, well supplied with beer. When the fishing parties returned, a few hours later, among their catch was a vicious looking barracuda. Liberty section number two gave up the idea of swimming.

The next day, we pulled alongside the pier to load 116,000 barrels of cargo oil and motor gas. Arabia had no trouble in sparing it. Geologists have estimated that there is 25,000,000,000 barrels of oil within a 50 mile radius of Ras Tenura. That figure is 2 billion more than the United States' total resources in all parts of the country. And this was just one of Arabia's fields. They have others just as large in other parts of the country.

On December 18th, with a full cargo of oil, we backed away from the pier and began the long trip home. Although the 80 degree temperature in December was very much enjoyed by most of the crew, none were particularly unhappy about laving Ras Tenura—which was now popularly known as "Horse-Manura." Shore leave, even had it not been strictly forbidden, was most unattractive here. The trip home, though over a route now familiar, was not of necessity a dull one. Christmas time found the ship in the Red Sea again, and the crew organized a Christmas show. Red Cross packages with turtle-neck sweaters were handed out as gifts. On December 27th, we entered the Suez canal again and by this time the turtle-neck sweaters were very much appreciated. Once into the Mediterannean we were reminded that it was still winter in the northern latitudes. On New Years day the Pillars of Hercules (Straits of Gibraltar) again came into view. Aboard the Canisteo, it was pay day—it's always pay day one day out of port and on January 2nd, the 99 was to drop the "hook" in Tangier Bay where the crew was to have its first good liberty in five weeks.

Tangier is an international city in Spanish Morocco. The population is made up mostly of Arab, African, and Spanish, although almost all nationalities seem to be represented. It was the popular opinion among the crew that the skipper had picked Tangier as the liberty port since it was an international city and utterly impossible for anyone to get into trouble there. This point, however, was questionable and I was very relieved when I checked the watch list and found that I did not have shore patrol duty. The liberty was what it might have been expected to be for a crew which had been at sea for five weeks.

On January 3rd, we began the last leg of the trip. Bad weather was expected. We found terrible weather. We were caught in a series of North Atlantic storms. Winds of 56 knots (62 m.p.h) whipped up 15 and 20 ft. waves. The Canisteo groaned and lurched through them. Our course was such that the 99 was taking an appreciable roll and even though I was no longer bothered with sea-sickness, I found it almost impossible to sleep in the new style rigid bunks which the ship had. Now I could appreciate the use of hammocks that sway with the ship rather than roll you over in bed. On the third day, the skipper ordered a change of course to ease the situation. Tankers are known to break in half in heavy seas such as this and it was the general opinion that for this reason the skipper ordered the change in course. We lost 15 miles that day. The next day found the wind subsiding somewhat, and so the Canisteo went back "on course." On January 14th, after 11 days of fighting the Atlantic, the 99 tied up at Norfolk Naval base again. Statistics for the complete trip indicated that the Canisteo had carried us over 20,555 miles of blue water in 50 days of sailing. Ship and crew were "saltier" by one two-month Arabian cruise.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# Richard J. Conway, Lehigh '51, selects Manufacturing Engineering at Worthington

**RICHARD CONWAY** checks cutting tool with machinist before milling a pump casing.

After completing his general training which brought him in contact with all departments, Richard J. Conway decided that manufacturing engineering was his field. He says, "I chose the Manufacturing Engineering Department after completing my general training at Worthington because as a graduate in Industrial Engineering I can learn the practical aspects of my field while applying theory I learned in college.

"The personnel of this department work together as a team toward the solution of the numerous problems which arise daily. We have the cooperation of all other departments in the corporation in getting the necessary facts pertinent to the solution of these problems. In the course of our day it may be necessary for us to meet the Plant Manager, Chief Engineer, Comptroller, several department heads, clerks, foremen, machinists and many others throughout the company.

"I have contributed to the solution of many problems handled by this department including metal spraying, machining procedures, purchasing new equipment and designating proper dimensions to obtain desired fits between mating parts.

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***FOR ADDITIONAL INFORMATION,*** see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

**WORTHINGTON**

The Sign of Value Around the World

# Atomic Electric Power

A new reactor will designed, built, and operated by North American Aviation, Inc., as part of the Atmocic Energy Commission's program to develop competitive nuclear power, the company announced today.

This new reactor work will be jointly financed by North American and the Atomic Energy Commission. The entire project will cost about $10 million, including research and development. North American will assume $2.5 million of this cost. In addition the company will provide land for the reactor site, which is to be located near the company's present rocket engine field test laboratory in the Santa Susana Mountains just north of the greater Los Angeles area.

The reactor, called the SRE (Sodium Reactor Experiment) will be a "sodium-graphite" nuclear reactor generating 20,000 kilowatts of energy in the form of heat. This type reactor will operate at higher temperatures than do some other reactor types. This is expected to result in high over-all plant efficiency.

Because the most essential development problems are in the reactor and heat exchanger system rather than in turbines and other generating equipment, no electricity will be produced at this time. When fission occurs in the reactor, heat will be produced. This heat will be transferred to liquid sodium circulating through the "core" of the reactor where the fission takes place. The sodium will then be pumped to an exchanger where the heat will be removed. If electricity were to be produced, the heat would be used to make steam, which in turn would drive a turbo-generator.

While it is not difficult to produce electricity from atomic energy, a large amount of technical development is necessary to reduce the costs of the process. Economical electrical power from atomic enrgy depends upon the production of useful heat in a reactor at a cost comparable with the present methods using conventional fuels such as coal and oil.

Work with the SRE is expected to provide some of the detailed engineering experience and to develop some of the operational equipment needed to produce economical power. Several other avenues of study are being followed in the AEC's program to develop nuclear power technology.

The development of fuel elements and various combinations of fissionable materials for the reactor core will be an important part of the program. The reactor is slated to use uranium slightly enriched in Uranium 235 in the core. Studies can a!so be made with Thorium, and Uranium 233 in the core.

Characteristics of sodium which made it particularly suitable as reactor coolant are the metal's low neutron absorption qualities, good heat transfer properties, low melting point, and high boiling point. Use of sodium permits the production of the high temperature without high pressure.

The reactor, including the core and the cooling sodium, will be encased in a steel tank. This entire unit is to be installed underground, with five feet of dense concrete between the reactor and ground level.

Graphite, used to moderate or slow down the neutrons which cause the Uranium 235 to fission, will surround the fuel. The design calls for 10,000 gallons of sodium to flow through the core, and absorb the heat of the fission process.

Boron-steel control rods will regulate the fission rate of the reactor, and are to be moved by electric motors in and out of the core. Such rods control the fission process by absorbing neutrons. Safety elements will serve to stop fission and shut down the reactor when required.

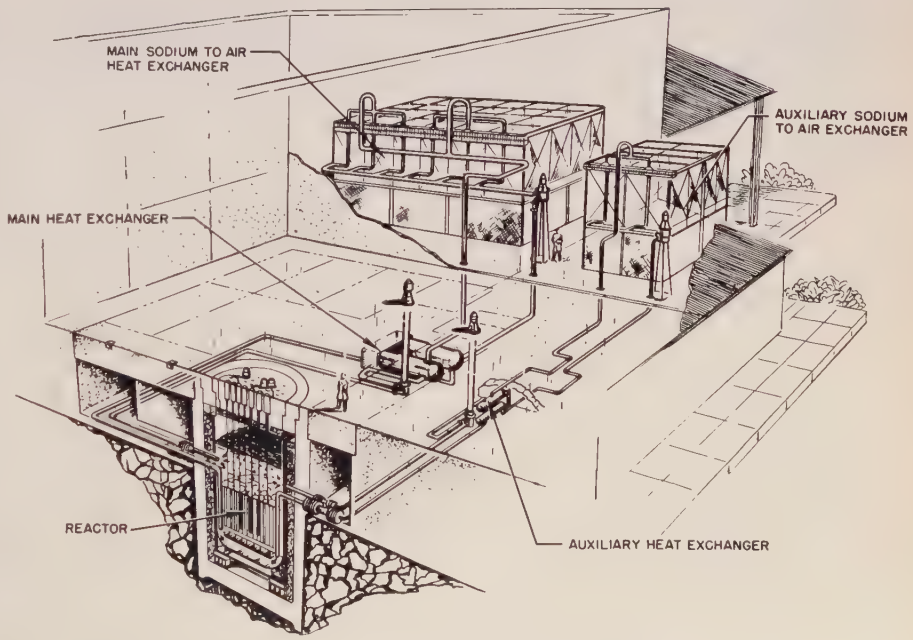
The sodium will be heated and pumped to a primary heat exchanger. Because the sodium coming directly from the reactor will be radioactive, this metal will give up its heat through a primary exchanger to another sodium circulation system. The second system will take the heat via uncontaminated sodium to a second exchanger where the heat ca nbe provided without the presence of radioactivity.

No fumes, gases, or other exhaust material will be emitted into the atmosphere, as the reactor will operate on a closed cycle system.

The reactor will be housed in a building about 100 feet long and 50 feet wide, with a 45 feet high bay area overhead. Including the connecting buildings, which will house machine shop, laboratory and office facilities, a total of about 20,000 square feet of covered floor area will be used for the SRE project. Only three technicians will be required to operate the reactor. Other engineers and scientists at the site will conduct various investigations and studies for the industrial power development program. Construction of the reactor is slated to begin shortly with completion expected in about two years.

Shortly after the end of World War II, North American began research and development work in the atomic energy field. Since 1948 the company has been engaged in reactor design and development work, together with associated projects, for the Atomic Energy Commission.

Within a few short years cheap electricity in the home and in industry will provide cheaper and better engineering materials.




This is the artist's conception of the "sodium-graphite" nuclear reactor, soon to be built.

# Which Sliderule?

by Don F. Kesler
E. E. '56

Do you jump when you hear the name of a slide rule? What does all that mumble jumble mean? To get to the log log duplex decitrig we have to start from the bottom and build up.

### *Mannheim Slide Rule*

In 1859 a young lieutenant in the French army named Amedee Mannheim started playing with logarithms. He invented the slide rule that hears his name today. No wonder it has lasted so long. It is the basis and most used part of the slide rules of today. The front of the Mannheim rule has four scales, marked A and B, C and D, because that is their name. C and D are both simple logarithmic scales, one is on the stationary part and the other is on the slide next to it. They can be used for multiplying, dividing percentage ratio, and proportion problems.

If you ever forget how to use your slide rule, just try a simple problem like two times two. Slide the slide until the one on the C scale is over the two on the D scale. Now all the numbers on the D scale are multiplied by two. Slide the hairline to the number on the C scale you wish to multiply by two. The answer at the intersection of the hairline and the D scale. Now you can tackle a difficult problem.

The A and B scale are just like the C and D scale only there are two of them half as long placed side by side. Now we can get squares and square roots easily. Suppose you want to know the square of two. Set the indicator at two on the D scale and read where the hairline crosses scale A. On my slide rule there is a four, the square of two. If you want the square root instead of the square, you start by moving the hairline to the number on the A scale, and the square root will be on the D scale.

On the back of the slide are the S, T, and L scales. The S scale refers to the A and B scales. It gives you the sines and cosines. T refers to C and D and is the tangent and cotangent functions. The L scale gives you logarithms —set the number on the D scale, read its logarithms on scale L. Except for a few tricks and short cuts that is all there is to the Mannheim rule.

### *Poly Phase Slide Rule*

A lot of things have been added to the slide rule in the last eighty years. The Polyphase Slide Rule is just a Mannheim rule with a couple of extra scales. The Polyphase has a C1 and a K scale that the other one doesn't. C1 stands for "C inverted"—it is just started from the other end. This may not sound like a lot of difference, but it makes a lot of difference in some problems. It lets us do multiplication of three factors with just one setting of the slide. It is very valuable in solving complex equations with long sequences of multiplication and division.

The K scale does the same thing for cubes and cube roots that A and B scales do for square figures. This is only the beginning of the simple problems you can do with your slide rule.

### *Polyphase Duplex Trig*

The Polyphase Duplex Trig has many helpful advantages the polyphase rule does not have. The most important is multiplying by pi. Three new scales have been added and three old ones have been reveampd. The new scales are called CF, DF, and CIF. This means "C folded," "D folded," and "C inverted and folded." Notice that CF and DF are the same as C and D except that they are folded to begin and end with $\pi$ or 3.1416. By a strange coincidence, every number on the D scale is automatically multiplied by $\pi$ on scale DF. And oddly enough, every number on the DF scale is divided by $\pi$ on the D scale.

In engineering calculations, $\pi$ keeps bobbing up all the time. You'll be surprised to find out how convenient it is to have multiplications and divisions reduced to such child's play. Right here the CIF comes automatically. Like the CI scale it performs multiplication, division, or both with one setting of the slide.

The trig scales have been revamped beautifully. The advantage of this over the Polyphase and Mannheim rule is the lack of transferring numerical trig values. This is accomplished by all trig scales referring to the C and D scales. No more changing from the A to the D scale.

### *Polyphase Duplex Decitrig*

The Polyphase Duplex Trig rule is made with a companion slide rule—the Polyphase Duplex Decitrig. The only difference being that the decitrig rule has its trig functions divided into degrees and fractions of a degree, instead of degrees and minutes and seconds. The main thing to be sure of is that you use the same graduations as the rest of the class.

Whoa, don't go out and buy a Polyphase Duplex Decitrig slide rule yet. While this is a good all purpose medium priced slide rule it is not the one for the earnest engineering student.

### *Log Log Duplex Decitrig*

Just how would you go about getting the answer to the problem $5^{4.5}$? You could look in the log tables and find the log of five and multiply it by 4.5, then trace down the number whose log it is. You could borrow your roommate's Log Log Duplex Decitrig slide rule and get out the instruction book. Then set the index of scale C over 5 on the LL3 scale. Slide the indicator to the 4.5 on scale C and read where the hairline crosses the LL3 scale. The answer is 1400, and it still did not take as long as with the tables. Think how short it would have been if you didn't have to borrow the slide rule and use the instruction book. On a slide rule, $165^{6.38}$ is just as easy to calculate as $2^2$.

### *Log Log Duplex Trig*

As you can guess this is the same as the Log Log Duplex Decitrig, except that the trigonometry is graduated in degrees, minutes, and seconds.

An engineering student will be buying two slide rules if he buys one without the log log scales or if he buys a smaller slide rule than standard size. It may seem like a large initial investment, but it will save on your electric bill, scratch paper and pencil fund. With a slide rule you have a fair chance of finishing an hour exam in fifty minutes.

---

At least one truck, planned as a pilot model for the future, will be equipped with tubeless tires as an experiment, according to Fleet Owner, McGraw-Hill publication. In the larger sizes there still are problems to be solved, but increased production on passenger car tires is providing an incentive for satisfactory tubeless truck tires, too.

---

A certain student's interest in a girl is proportional to the cube of her chest expansion and inversely proportional to the square root of their distance apart. Find the approximate per cent increase in his interest if he moves 1% closer and simultaneously discovers she has puffed herself up 2%.

---

A Scotchman and an Irishman were on board a ship bound for Scotland.

Scotchman (catching sight of his fatherland): "Hurrah for Scotland."

Irishman (riled): "Hurrah, hell."

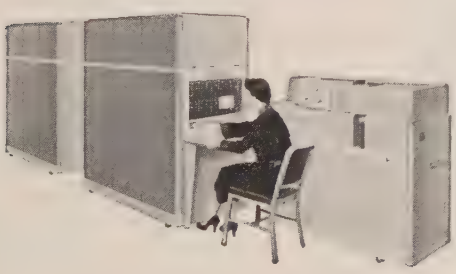
Scotchman: "That's right, every man for his own country."

Yesterday . . .
"The Fates" Decided
In the 6th century, B. C., King Croesus of Lydia was told by the Delphic Oracles he could defeat the Persians. Relying on "The Fates" instead of the facts, he took on an enemy he should have known was too strong for him ...and he was badly beaten. Lack of facts cost him his kingdom and his freedom.

*Croesus' cavalry stampeding at the sight of Persian camels*

# *Today . . . Facts Are What Count*

*Ask your placement officer for a copy of "Opportunities Unlimited—The Engineer in IBM Laboratories."*



The recent great strides in military science, pure science, commerce, and industry have resulted from modern man's ability to determine the facts and act accordingly

Tremendous advances have been made in the past few years in fact-finding machines. Through electronics, great masses of data that would have taken a lifetime to process can now be handled in a few days. Ordinary volumes of work can be done in minutes.

By making "mathematical models" of specific processes, products, or situations, man today can predetermine probable results, minimize risks and costs.

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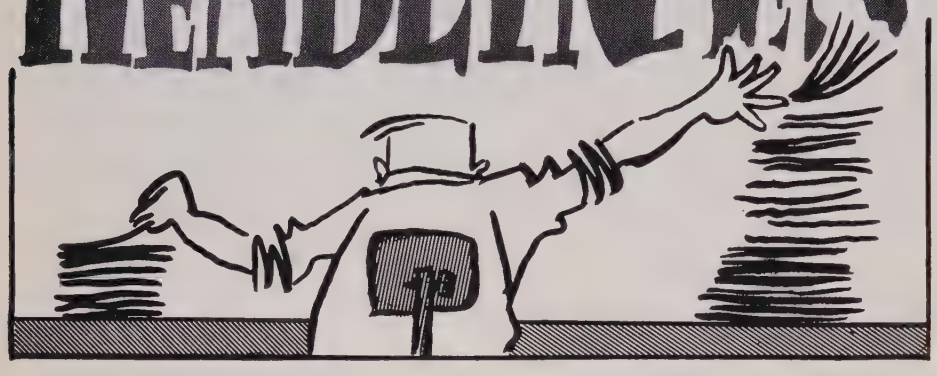
# SKIMMING INDUSTRIAL HEADLINES



by Henry Lowenthal, M. E. '58

## New Portable Radio-Phonograph

Majestic Radio & Television has announced the introduction of a truly portable radio-phonograph which will operate on self-contained batteries or house current.

Officials at Majestic explain that this is the first portable radio-phonograph made which incorporates a battery-operated phonograph motor utilizing a small battery pack containing inexpensive and easily obtainable standard B and A batteries.

Extremely lightweight and compact, the new unit weighs only 12 lbs., complete with batteries, measuring only 14″ wide, 10″ high, and 5″ deep. The case itself is made of wood, luggage covered, and available in a choice of four colors including red, light tan, green, and brown. All of the plastic and metal parts are precision machined and tooled for extreme dependability and beauty of design. The leather luggage carrying handle makes it easy to carry from place to place.

The basic operations are controlled by a push-button keyboard with separate keys for on-off, radio, phonograph, and a current economizing adjustment which serves to prolong the life of the batteries. This last key serves a dual purpose in that it also provides extra volume.

The radio has a built-in ferrite stick antenna which provides excellent reception and selectivity. The unit also includes a relatively large radio dial whose inner diameter encompasses the ingenious rubber-rimmed turntable. The volume control can be used for radio or phonograph.

The crystal pickup and sapphire needle in the minature tone-arm provide excellent fidelity in connection with the large elliptical speaker. The drop-lid of the case conveniently holds a supply of records in place with an elastic cord.

The newest thing in portable radio phonographs.

## New Office-Styled Coffee Vendor

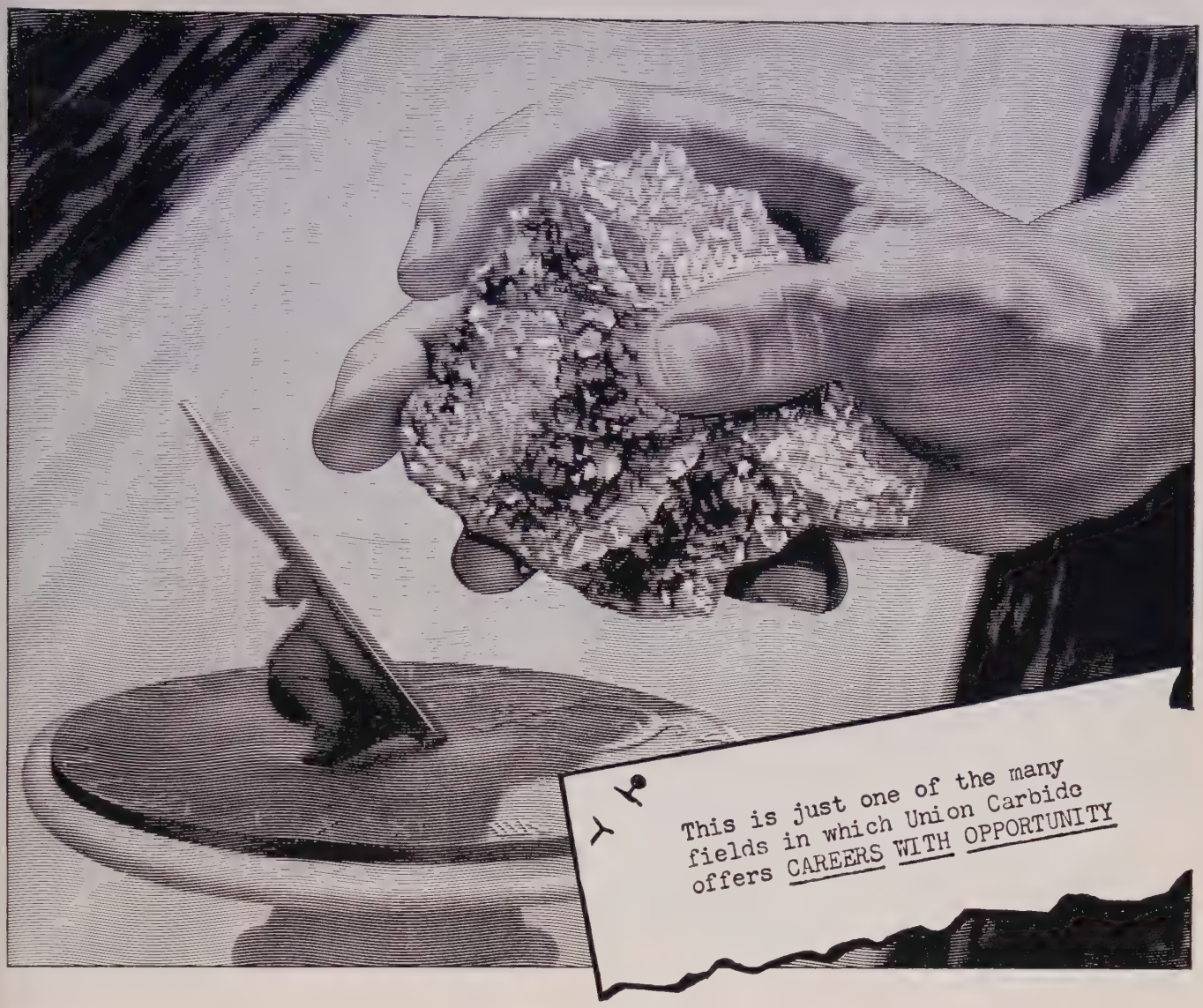
An office-styled coffee bar vending machine that promises to become as standard as the water cooler has been introduced by the Bert Mills Corporation, St. Charles, Ill. The new coin-operated, automatic vendor, easily installed close to work, serves the beverage at any time according to the user's taste—with or without cream or sugar, with both, or plain. Use of the vendor by small firms will chop costly coffee break overtime since office workers no longer have to go outside for the beverage.

### SUN-LOVING DOLLS

Dolls that will sunburn may be the next toy rage, according to Chemical Week, McGraw-Hill publication. A New Jersey laboratory has developed a doll that will tan when exposed to the sun and will revert to its original color when left indoors several hours.

### TOO FRESH TO EAT?

In Copenhagen, live trout were anesthetized, shock-frozen at 40 below, stored for four months, defrosted, and placed in water, whereupon they were found to be alive and swimming, Food Engineering, McGraw-Hill publication, reports. Noting that the British accomplished the same type of experiment with warmblooded animals (hamsters),




# *The metal that makes time stand still*

## Thanks to chromium, steel now serves you with strength and beauty that lasts a lifetime

IN TIME, one of man's most useful materials—steel—is often the victim of such destructive forces as rust, corrosion, heat, or wear.

**THESE NATURAL ENEMIES** of steel now are mastered by the metal called chromium. When the right amount of chromium is added to molten steel, the result is strong, lustrous stainless steel that defies the ravages of time.

**IN HOMES, TODAY,** stainless steel is a shining symbol of modern living. It brings us care-free sinks, gleaming tableware and kitchen utensils—all with beauty that lasts a lifetime.

**IN INDUSTRY**—Food is prepared in super-sanitary stainless steel equipment. Streamlined trains and buses are made of this wonder metal. Vital parts of jet planes that must withstand both blazing heat and sub-zero cold are made of tough, enduring stainless steel.

**SERVING STEEL... AND YOU**—The people of Union Carbide produce alloys of chromium for America's steelmakers. This is another of the many ways in which UCC transforms the elements of nature for the benefit of everyone.

**STUDENTS AND STUDENT ADVISERS:** *Learn more about career opportunities with Union Carbide in* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Write for booklet G-2.*

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the publication comments that it is fine for frozen fish and meat to be fresh—but not so fresh that it flops off the plate or walks across the table.

### WELDING SPURS SHIPBUILDING

Progress in welding is largely responsible for the fact that the few shipyards in West Germany turned out vessels totalling 725,000 tons in 1953 as against an average production of 250,000 tons by German yards before the war, Welding Engineer, McGraw-Hill publication, reports. Among exhibits at the recent Cutting and Welding Exhibition in Essen were welded high-pressure steam boilers, seamless welded parts of steel bridges, welded gas containers and ship sections.

The unskilled operator can easily use this flaw catcher.

## Flaw Catcher

A production gaging instrument that inspects four dimensions simultaneously on the carrier body of an automatic transmission is manufactured by The Sheffield Corporation, Dayton, Ohio.

In one quick operation, an unskilled operator can check the seat chamfer on the inside of the body, outside body diameter, over-all body length, and the dimensions from the top of the shank to the bottom edge of the upper flange.

Dimensional quality of the part is indicated by a master light and four individual signal lights on the diagram panel. When all of the dimensions are within tolerance, the master light remains white and the four signal lights on the panel black out. However, if one or more of the dimensions are out of tolerance, the master light turns red and the signal lights indicate the faulty dimensions by turning either red or green indicating respectively undersize or oversize. The lights of the correct dimensions black out.

## Electronics Hobby Kit

The how's and why's of basic electronics are unfolded for youngsters in a new educational hobby kit manufactured by the Radio Corporation of America.

Youngsters can actually construct one and two-tube radio receivers and transmitters, chemical batteries, and experiment with sound and electricity from materials in the kit.

The electronics kit is the first in a series of such kits by RCA. Future kits will advance in detail until youngsters following the series will have a full-rounded knowledge of electronics.

A profusely illustrated book of instructions, prepared under the guidance of Encyclopedia Britannica, accompanies the kit.

Youngsters working from the first kit start by rubbing two pieces of paper together, thus inducing a flow of electrons. The electrons can be discovered and measured by the assembly of a galvanometer or current detector built from the contents of the kit.

Experiments with a head set allow youngsters to hear the electrons as they are produced.

By inserting strips of copper and zinc from the kit into ordinary lemon or salt water solution, the youngster then makes a chemical battery. He can use the battery to power a telegraph and can listen to the message with the earphone.

Additional experiments lead the youngster to the stage where he assembles and operates a simple low-powered radio transmitter. Finally, he can build the two-tube radio receiver and one-tube transmitter.

Contents of the kit include a variable timing condenser, plate coil, antenna coil, dial, "B" battery clip, ground clamp, 6-wire lead, coil antenna wire, screwdriver, coil magnet wire, steel rod, zinc strip, copper strip, compass, headphone and clamp, timing knob, mounting bracket, coil ground wire, and reversible assembly board.

Also included are two resistors, "A" battery clips, tube sockets, vacuum tubes; three capacitors; and one assortment of Fahnestock clips, screws, nuts, etc.

## TV Set of 1964

General Electric scientists here envision the TV set of 1964 with a picture screen so thin that the complete unit could be hung like a painting on your living room wall. The circuitry would be built into the picture frame and would use printed wiring and miniaturized components. Controls would be located in a small box beside your easy chair.

Or for those who might prefer a table model, the thin picture screen would be mounted like a vanity mirror, attached to slender arms extending upright from a small oblong cabinet which would house the circuitry and controls.

These futuristic models, at least 10 years off, would receive color as well as monochrome pictures.

The POW, or "picture on the wall" TV receiver is just a glint in the scientists' eyes at the moment. But they are convinced such a unit can be developed and have designed a dummy receiver to help visualize the future TV unit.

As explained by Dr. Lloyd T. DeVore, manager of the G. E. Electronics Laboratory, the POW vision of the future stems from development work being done here on new minature electronic components, and from a complex project underway to speed the plotting of aircraft in military filter centers.

At present, this aircraft plotting, essential to successful interception of enemy planes, is done manually. The planes are followed by radar operators and information fed to plotters who pinpoint the planes with crayon on the transparent wall-size plotting board.

The plotting would be done automatically with the POW type of board.

Dr. DeVore says the radar display system under development will use elec-

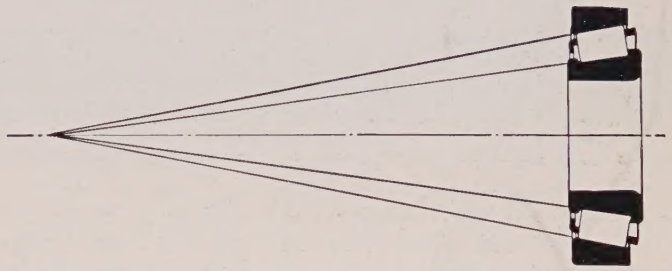
*Another page for* **YOUR BEARING NOTEBOOK**

## How to design a freight car one man can push

You can make a big 55-ton freight car roll so easily one man can push it. How? By mounting its axles on Timken® tapered roller bearings. Timken bearings *roll* the load, eliminate the metal-to-metal sliding friction that makes old-style friction bearings start hard. They reduce starting resistance 88%. And, with Timken bearings, there's no danger of hot boxes —the major cause of freight train delays.

## TIMKEN® bearings are designed to roll the load

As you see here, all lines drawn coincident with the working surfaces of a Timken bearing meet at a common point on the bearing axis. This means Timken bearings are designed to give true rolling motion. And, since they're tapered they can take radial and thrust loads in any combination.



**TIMKEN**
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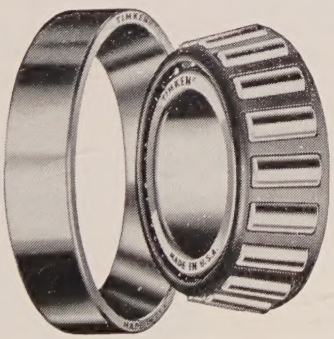
*TAPERED ROLLER BEARINGS*



## Want to learn more about bearings or job opportunities?

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

**NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ◎ AND THRUST —◎— LOADS OR ANY COMBINATION**



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tronic computer circuitry techniques to convert a transmitted signal into an image on the plotting board.

The plotting board screen will be composed of a space matrix constituted by closely spaced perpendicular wire grids luminescing at their intersections to reproduce the transmitted picture.

Development of speedier switching techniques and new fast-reacting electroluminescent phosphors are needed before the POW system could be applied to television receivers, Dr. DeVore said.

## Fluorescent Lamp Life Tester

Scientists now almost instantly can predict approximately how long a particular fluorescent lamp will burn — something which formerly could be found out only by burning it until it blinked out after an average period of 7500 hours.

This was revealed by Richard N. Thayer, lamp development engineer for General Electric at Nela Park, Cleveland, in a paper on "Determinants of Fluorescent Lamp Life," presented at the National Technical Conference of the Illuminating Engineering Society.

Other things being equal, the life of a fluorescent lamp is proportional, according to Thayer, to the amount of a chemical called "emission coating," held by the lamp's cathode. By weighing this emission material, which serves as the source of electrons to carry the current through the lamp, the life of a lamp can be estimated.

The development engineer said his organization had developed a novel electronic method which permits rapid testing of fluorescent lamps for the quantity of chemical on their cathodes, but without breaking open or even lighting the tubes.

In this method, Thayer explained, the lamp under test is compared in an electronic circuit with a lamp having an uncoated cathode. When the current is applied, the coated cathode is slower to increase in temperature. This difference in resistance to heating is roughly proportional to the weight of the emission coating, and can be read on a meter.

The getting of the desired quantity of chemical on the cathode, and retaining it there through all lamp processing and handling steps, requires close controls, according to the G-E engineer. He said many checks are made to insure high quality. The new electronic tester is said to be an especially useful control tool in detecting short-life lamps.

## The Rhino

The Rhino amphibious vehicle is the first vehicle which successfully traverses mud flats, marshes, rough terrain and also cruises in water, according to C. Alfred Campbell, vice president of Marmon-Herrington, builders of the Rhino.

"Every other amphibious vehicle we have evaluated over our many years of experience has trouble when it leaves the water and attempts to cross soft mud flats at the water's edge," said Mr. Campbell.

An idea conceived by inventor Elie P. Aghnides, the Rhino has been under construction and exhaustive test since 1948 by skilled engineers at Marmon-Herrington.

The new vehicle can negotiate swamps, soft mud, sand, climb 65 per cent grades, or travel down the highway at 45 m.p.h. With Hydrojet propulsion, the Rhino may be operated and maneuvered in deep water.

The first basic change in a thousand years in that great invention, the wheel, is responsible for the success of this vehicle.

The Rhino has a huge pair of hemispheroidal hollow spun aluminum wheels in front, plus a smaller pair in the rear. For highway operation, only a narrow rubber tread touches the road. In soft places, the traction area is increased with every inch of sinkage of the hemispheroidal wheels.

The Rhino is floated in deep water by the large hemispheroidal wheels and by its watertight body. Power and steering in the water are provided by a Hydrojet, making the Rhino so maneuverable in water that it turns easily in its own length.

Track laying vehicles usually are heavy and cumbersome, slow on hard surfaces, and unable to ford streams. The Rhino, even the present prototype version, will traverse paved roads, mud, swamp and water as required.

## ASME SYMBOL AND MOTTO

The American Society of Mechanical Engineers has announced the names of winners in its contest to find a suitable symbol and motto for its 75th anniversary celebration in 1955.

Andrew T. Lemmens, design engineer with The Gleason Works, Rochester, New York, will receive $250 for his prize winning design. David H. Ray, retired mechanical engineer of North Tarrytown, New York, received the top award of $250 for his motto, "By Truth and by Service."

Mr. Lemmens' design combines a representation of the intersecting orbits of the atom—traditional symbol for nuclear power—with a representation of the thermodynamic cycle, by which heat is converted into energy and back again.

# "Allis-Chalmers Graduate Training Course Gave me a head start"

**says GERALD SMART**

*Marquette University, BS—1948*
*and now Supervisor of Plant Engineering,*
*Allis-Chalmers, Norwood, Ohio, Works*

"MOST MEN graduating from college don't have a clear idea of what they want to do. These individuals are helped by Allis-Chalmers Graduate Training Course to find the right job whether it be in design, sales, engineering, research or manufacturing.

"My case is a little different, however. I started the course with all my interest centered on tool design and 'in-plant' service. The reason is that I started getting vocational guidance from some very helpful Allis-Chalmers men back in 1940."

### Served Apprenticeship

"At their suggestion I had gone to school part time while working full time. This not only gave me the chance to serve an apprenticeship as a tool and die maker, and earn money, but I learned what I wanted to do after graduation.

"Then came the war and service in the Navy. After the war I finished school. By the time I started on the course in 1948, I knew what I liked and seemed best fitted to do. As a result, my entire time as a GTC student was spent in the shops.

"The 18 months spent in the foundry, erection floor and machine shop have all proved valuable background for my present job.

"As supervisor of plant engineering at the Norwood Works, I am concerned with such problems as: Plant layout, material handling equipment and methods, new construction, new production methods to be used in building motors, centrifugal pumps, and *Texrope* drives. It's an extremely interesting job.

"From my experience, I'd say, whether you're a freshman or a senior it will pay you to talk to an Allis-Chalmers representative now. You can't start planning your future too soon. And you can't plan starting at a better place, because Allis-Chalmers builds so many different products that you'll find any type of engineering activity you could possibly want right here."

### Facts You Should Know About the ALLIS-CHALMERS Graduate Training Course

**1.** It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

**2.** The course offers a maximum of 24 months' training. Length and type of training is individually planned.

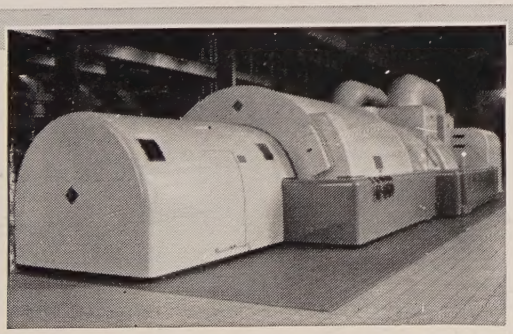
**3.** The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

**4.** He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

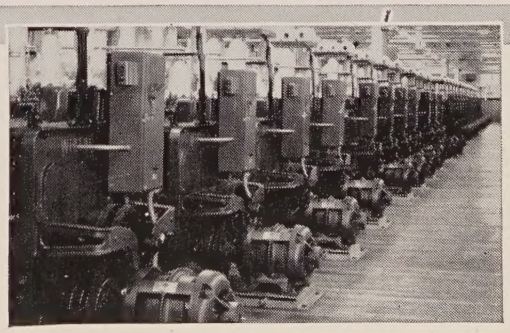
**5.** He will have individual attention and guidance of experienced, helpful superiors in working out his training program.

**6.** The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisc.



**Steam turbines,** condensers, transformers, switchgear, regulators are built for electric power industry.



**Motors, control,** *Texrope* V-belt drives—all by Allis-Chalmers are used throughout industry.

# ALLIS-CHALMERS

*Texrope* is an Allis-Chalmers trademark.

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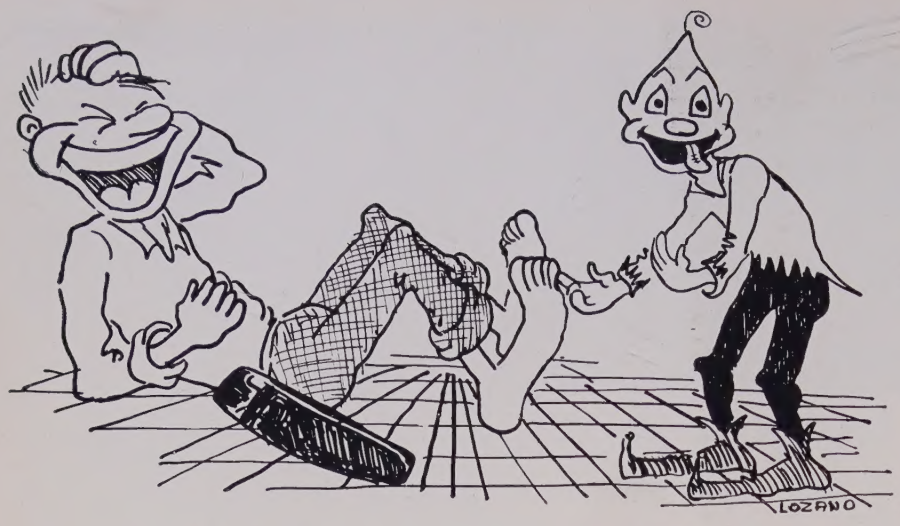


# TECHNOCRACKS

"How did you get so completely intoxicated?" asked the judge.

"I got in the wrong company, your Honor. You see, there were four of us; I had a fifth of bourbon—and the other three didn't touch the stuff!"

* * *

Salesman: "Is your mother engaged?"
Little boy: "I think she's married."

* * *

Frosh: "Would you please repeat the question?"
Soph: "Beg pardon?"
Jr: "Huh?"
Sr: "Z-Z-Z-z-z-z."

* * *

Dr. Collins was lecturing: "I predict the end of the world in fifty million years."

"How many?" cried a frightened voice from the rear.

"Fifty million years."

"Oh," said the voice with a sigh of relief, "I thought you said fifteen million."

* * *

Engineer: "This new book on health says that bathing alone won't keep you healthy."

Coed: "Well, I don't care what it says, I'm going to keep right on bathing alone."

* * *

An inmate of a certain insane asylum, feeling that he had recovered enough to be released, appeared before the desk of the superintendent. After he was partially examined he was asked the following question:

Superintendent: "If we discharge you, will you promise to let women and liquor alone?"

Inmate: "Yes, sir."

Superintendent (beckoning a guard): "Lock him up; he's still crazy."

A dog and a cat became embroiled in a street corner fight, and a big crowd gathered to watch. One unruly spectator suddenly whipped a gun out of his pocket and shot the dog. A policeman heard the report and came running on the double. The killer threw his gun to the ground and appealed to the crowd. "Don't say a word to the cop. He'll think the cat did it."

* * *

College boy pouring drinks, "Say when."

College girl, "Right after this drink."

* * *

Ken: "What did the usherette say when her strap broke?"

Ray (always the straight man): "I dunno."

Ken: "I have two down in front."

* * *

Confuscius says, "Modern woman putting up such a false front, man never knows what he is up against."

* * *

A truck driver, hauling clay for a fill, backed his truck too far over the dump grade. The weight of the load being dumped lifted the front end of the truck several feet off the ground.

"Now, what are you going to do?" an associate asked.

The driver eased out of the cab and said, "I think I'll grease it—I'll never get a better chance."

* * *

"This model has a top speed of 130 miles an hour, and she'll stop on a dime."

"What happens after that?"

"A little putty knife comes out and scrapes you off the windshield."

* * *

You can tell that Americans trust in God by the way they drive.

Listen, my daughter, and you shall hear
The fate of the wife of an engineer.

Let my words be your solemn guide:
His slide rule is always by his side.

He'll stay with you, through sun or rain . . .
'Til St. Pat calls, and he's off again.

An electrical clutters your living-room floor
With radio carcasses by the score;

A civil may buy pearls and mink,
But he can't fix the kitchen sink;

Mechanicals have grease in their fingernails;
A chemical's kind, but lord, how he smells!

The dweller in halls with the shamrock above
May look attractive, but oh, spurn his love.

His love words are tender, his presence is fun,
'Til he speaks of the square root of minus one.

For he and his friends speak a tongue that's unknown,
And the company you keep will be largely your own.

* * *

Social Worker: "Sir, would you be interested in contributing something to the old ladies home?"

Spendthrift: "Sure, I'll send my mother-in-law over tomorrow."

* * *

But driver: "How old are you, little girl?"

Little girl: "If you don't mind, Buster, I'll pay full fare and keep the statistics to myself."

* * *

Med. Student: "I want to change the death certificate I gave you yesterday."

Professor: "What's wrong?"

Student: "I signed my own name in the space marked cause of death."

* * *

C.E.: "I have here the one and only cure for dandruff."

Date: "Really, how does it work?"

C.E.: "Oh, it's really simple—it's a mixture of alcohol and sand."

Date: "But, how does it cure dandruff?"

C.E.: "Well, you just rub the mixture on your hair; then the bugs get drunk and kill each other throwing rocks."

* * *

Where'd yawl git that Southern accent?

Honey-chile, I'se been drinking outen a Dixie Cup.